VOLUME 58 NUMBER 3

# ARCHIVES OF SURGERY

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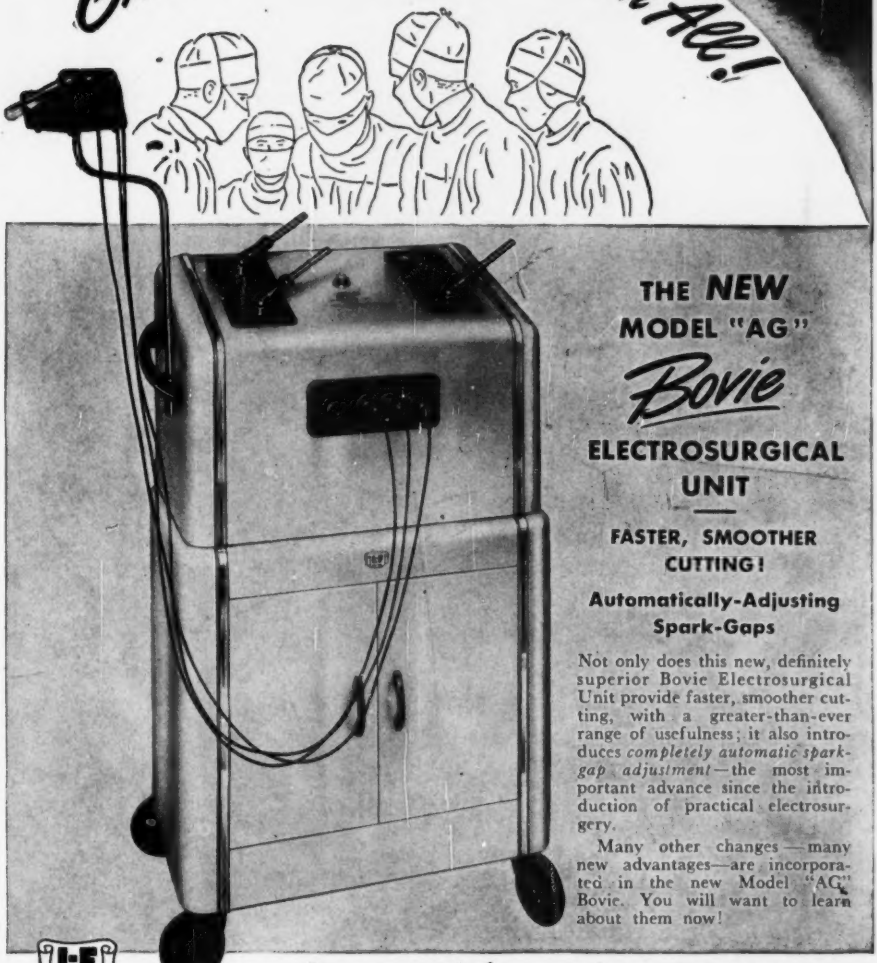

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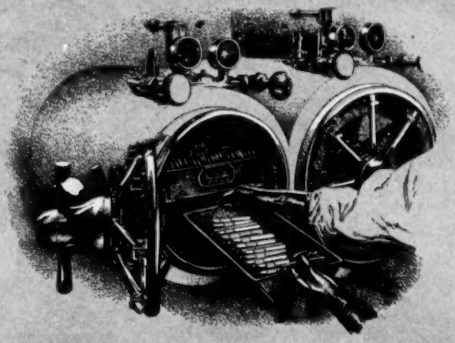

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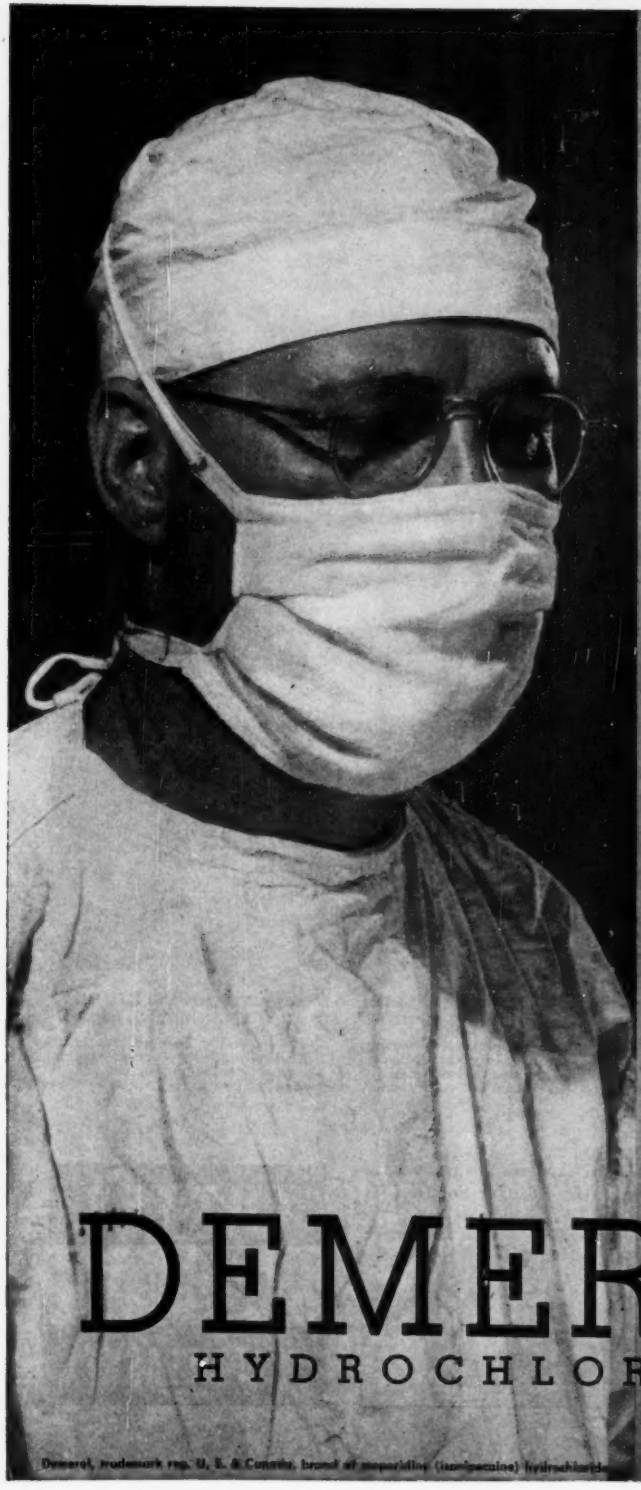

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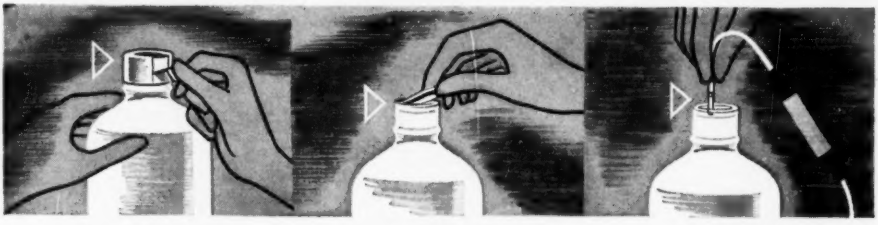

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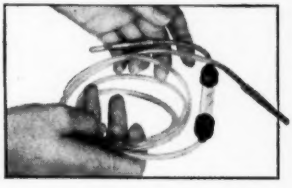

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ARCHIVES OF SURGERY

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# SURGICAL TREATMENT OF ULCERATIVE COLITIS

GARNET W. AULT, M.D.
WASHINGTON, D.C.

AN ANALYSIS of our files on patients with ulcerative colitis to Sept. 1, 1947, has indicated that approximately 15 to 20 per cent of them have reached an advanced stage of this disease. If one is correct in assuming that 15 to 20 per cent of all patients with chronic ulcerative colitis advance to the stage of chronic medical invalidism, disability and an unemployable status, then selective surgical treatment should be offered to this group. A restoration to health and occupation should be the yardstick by which the results of surgical treatment are evaluated.

A survey of the reports of Cave,[1] Jones,[2] Rankin,[3] Cattell,[4] Dixon,[5] Kiefer,[6] Bargen,[7] Crohn,[8] Bockus,[9] Cave and Mackie,[10] Dennis,[11]

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Read before the Section on Gastro-Enterology and Proctology at the Ninety-Seventh Annual Session of the American Medical Association, Chicago, June 23, 1948.

1. Cave, H. W., and Thompson, J. E.: Mortality Factors in the Surgical Treatment of Ulcerative Colitis, Ann. Surg. **114**:46 (July) 1941.

2. Jones, T. E.: Surgical Treatment of Ulcerative Colitis, J. A. M. A. **111**: 2076 (Dec. 3) 1938.

3. Rankin, F. W.: Chronic Ulcerative Colitis, South. M. J. **34**:464 (May) 1941.

4. Cattell, R. B.: Indications for Colectomy in Ulcerative Colitis, S. Clin. North America **24**:656 (June) 1944.

5. Dixon, C. F.: Surgical Treatment of the Dysenteries, Minnesota Med. **19**:33 (Jan.) 1936.

6. Kiefer, E. D.: A Review of the Problem of Chronic Ulcerative Colitis, Tr. Am. Proct. Soc., 1946, p. 487.

7. Bargen, J. A.; Jackman, R. J., and Kerr, J. G.: Studies on the Life Histories of Patients with Chronic Ulcerative Colitis, Ann. Int. Med. **12**:399 (Sept.) 1938.

8. Crohn, B. B., and Rosenak, B. D.: A Follow-Up of Ulcerative Colitis, Am. J. Digest Dis. & Nutrition **2**:343 (Aug.) 1935.

9. Bockus, H. L., and others: Prognosis of Ulcerative Colitis, J. A. M. A. **111**:2078 (Dec. 3) 1938.

10. Cave, H. W., and Mackie, T. T.: Chronic Ulcerative Colitis, South. M. J. **31**:414 (April) 1938.

11. Dennis, C.: Surgery in Relation to Chronic Ulcerative Colitis, Minnesota Med **28**:228 (March) 1945.

Garlock,[12] Ravich[13] and many others has indicated that surgical treatment will rehabilitate a greater number of patients than is generally recognized.

### STATUS OF THE PATIENT

Patients who have experienced an *initial* acute fulminating attack of chronic ulcerative colitis are not considered candidates for surgery. It is felt that this disease is primarily a medical problem, and patients in this category should not be denied the opportunity to become rehabilitated by medical management. The results of the surgical treatment of early ulcerative colitis are not impressive, although I am aware of the experimental work now being done in regard to vagotomy.

Patients who have had chronic or recurrent ulcerative colitis for several years may be considered candidates for surgery. These seriously ill patients must be classified as poor surgical risks, and discretion must be exerted regarding the extent and timing of the surgical procedures.

### SPECIFIC INDICATIONS FOR SURGICAL INTERVENTION

The following indications for surgical intervention are presented because it is felt that they represent a means of rehabilitating many patients.

*1. Chronic Ulcerative Colitis with Constitutional and Visceral Degenerative Changes.*—Patients with this condition have had chronic ulcerative colitis for months or years, so that they are chronic invalids. Recurrent or continuous disability is associated with their sepsis, toxemia, anemia, malnutrition and vitamin deficiencies. Amenorrhea and absence of development of the breasts and of other secondary sex characteristics will occur in young women. In both sexes the results of hepatic function tests will be altered and biopsies of the liver will show marked pathologic changes. Some of the complications such as pyoderma, recurrent cutaneous ulcers, furunculosis, neuritis and stomatitis have been classified in the past under focal infection. It is doubtful if any of these exist alone, as they are ordinarily a part of the entire disease process. They should be included in the constitutional and visceral category. A disabling polyarthritis that has not progressed to the point of structural change should also be included in this group. A disability of 80 to 90 per cent with reference to education or employment will be present in most of these patients.

*2. Anorectal Complications.*—Patients in whom recurrent anal ulceration and perirectal infection develop in the form of abscesses and

12. Garlock, J. H.: Surgical Treatment of Intractable Colitis, Ann. Surg. **113**:2 (Jan.) 1941.

13. Ravitch, M. M.: Personal communication to the author.

fistulas are indeed disabled. Decreased rectal capacity from tubular stricture leads to incontinence, as does rectovaginal fistula. Incontinence following fistulectomy is common, so that local surgical treatment, except for the adequate drainage of abscesses, is unsatisfactory. Good health and employment are rarely attained by these patients until major surgical treatment solves their problems.

*3. Polypoid Degeneration and Carcinoma.*—Patients with polypoid degeneration demonstrable by repeated roentgen and proctoscopic examinations should be considered candidates for surgery. The exceptions to this rule are few if it is conceded that the potentiality for malignant degeneration is great.

*4. Obstruction and Tumor Mass.*—A diagnosis of malignant growth is favored if previous evidence of polypoid degeneration is available. However, if one is confronted with the problem of obstruction from an abdominal or an abdominopelvic mass, the character of the lesion can rarely be determined until histologic study of the resected specimen is performed. Proximal colostomy or ileostomy is advocated preliminary to resection.

*5. Perforation, Abscess and Fistula.*—A slow perforation that localizes to form an abscess should be drained. When an abdominal, pelvic or visceral fistula develops, proximal colostomy or ileostomy should be done before resection of the involved bowel or structures is attempted. These complications are a part of the disease process in the colon, and local repair is not advised, nor is it generally successful.

*6. Segmental Ulcerative Colitis.*—If one can prove by repeated proctoscopy and roentgen study that the rectum is not involved, consideration should be given to early surgical treatment of the segmental type of ulcerative colitis. This may consist of ileosigmoidostomy when the right half of the colon is involved. Anastomosis between the right transverse colon and the lower end of the sigmoid or rectum may be indicated when a segment of the left colon is involved. Simultaneous exclusion of the involved segment of the left colon by exteriorization is advised.

### QUESTIONABLE INDICATIONS FOR SURGICAL INTERVENTION

The following questionable indications for surgical intervention are most controversial. The results of the surgical treatment for these phases of ulcerative colitis are not impressive. They are discussed because I personally feel that they should be abandoned.

*1. Hemorrhage.*—Acute, continuous or recurrent hemorrhage is rarely an indication for operation. A reduction in the total blood volume in most patients should be restored by replacement with whole blood, protein solutions and other intravenously administered adjuncts. Massive parenteral doses of vitamin K, vitamin C, nicotinic acid, vitamin B complex and liver are a part of this supportive treatment. Total

parenteral alimentation is indicated, and nothing is administered orally. Surgical intervention should be deferred until the patient becomes an acceptable surgical risk after response to this medical regimen.

*2. Acute Fulminating Ulcerative Colitis.*—Patients in whom an *initial* acute fulminating attack of ulcerative colitis develops should be considered medical problems. The profound sepsis, toxemia, acute malnutrition and deranged physiologic process associated with severe denudation of the colon usually result in a severe state of constitutional decline. These patients are not acceptable candidates for surgery, as past reports have indicated. The mortality is unquestionably too high, and if they survive this phase of the disease they may be operated on later with greater safety.

TABLE 1.—*Status of Operative Procedures*

| Operations | Procedure | Deaths | Mortality, % |
|---|---|---|---|
| 14 | Ileostomy | 2 | 14.2 |
| 4 | Left colectomy | 0 | 0 |
| 9 | Total colectomy | 0 | 0 |
| 6 | Abdominoperineal | 0 | 0 |
| 15 | Miscellaneous | 1 | 6.6 |
| 48 | | 3 | 6.2 |

TABLE 2.—*Mortality Status of 23 Patients*

| A. Postoperative Mortality | Deaths | Mortality |
|---|---|---|
| Ileostomy—perforated ileum | *1 | |
| Ileostomy—perforated colon | 1 | |
| Laparotomy—adhesions | 1 | |
| | 3 | 13% |
| B. Mortality of Ulcerative Colitis | | |
| Ileostomy—enterocolic fistula | 1 | |
| Colostomy—inoperable carcinoma | 1 | |
| | 2 | 8.7% |

*3. Acute Perforation.*—Perforation into the free peritoneal cavity during the *initial* acute fulminating stage of ulcerative colitis is invariably fatal. A spreading virulent peritonitis accompanied with multiple abscess formation is ample evidence of the futility of treatment. This may be dramatically illustrated at autopsy when one attempts to deliver a necrotic bowel from the abdominal cavity.

## SURGICAL PROCEDURE

As of Sept. 1, 1947, 120 patients were seen and 23 were operated on. The results of forty-eight major abdominal surgical operations are presented in table 1.

## MORTALITY STATUS

The mortality status of 23 patients in relation to the surgical treatment and in relation to the disease is presented in table 2.

### POSTOPERATIVE STATUS

The postoperative status of these 23 patients in relation to rehabilitation is presented in table 3.

### COMMENT

From the results of the surgical treatment of ulcerative colitis in table 1 it is apparent that ileostomy alone can be a formidable procedure. It is hoped that a lower mortality rate will be approached in the future. Under miscellaneous procedures, segmental resections, partial colectomies, ileosigmoidostomies, operations for abdominal and visceral fistulas and explorations for obstruction from adhesions were performed. A spontaneous enterocolic fistula developed in 1 patient subjected to ileostomy. This effectively nullified the results of the operation, and the convalescent patient's death at home is correctly assigned to an active return of his disease. The development of carcinoma (unresectable) in ulcerative colitis is an example of malignant polypoid degeneration which is indeed unfortunate.

TABLE 3.—*Postoperative Status of 23 Patients*

| Status | No. | % |
|---|---|---|
| Restored to health | 16 | 69.5 |
| Convalescent | 1 | 4.3 |
| Rehabilitated | 17 | 73.8 |
| Postoperative mortality | 3 | 13.0 |
| | 2 | 8.7 |
| Dead | 5 | 21.7 |
| Unknown | 1 | 4.3 |

The most encouraging aspect of this entire program was the rehabilitation status of the patients. Approximately 75 per cent of these seriously ill, disabled patients were restored to health and occupation. I doubt if I can report such a favorable rehabilitation status a few years from now, for I am acutely aware that regional enteritis affecting the ileum and jejunum has developed in some patients. However, if one can restore at least 50 per cent of these persons to health and occupation, it is an impetus to continue with the work.

915 Nineteenth Street, N. W.

### ABSTRACT OF DISCUSSION

DR. JOSEPH BANK, Phoenix, Ariz.: Dr Ault has made a distinct contribution to our thinking about ulcerative colitis. There is no unanimity of opinion concerning the proper time for operation. We are faced with the problem of employing both medical and surgical measures most judiciously in this baffling disease.

It has been properly emphasized by Dr. Ault and others that mild cases or initial acute fulminating attacks are medical problems. Surgical treatment in the

latter group is hazardous. The same may be said for operation under emergency conditions. Conservative surgeons agree that some cases of segmental colitis and complications of ulcerative colitis should have the benefit of surgical intervention. These are obstruction, impending or actual perforation under certain conditions, anorectal complications, polypoid degeneration or suspected maligant growths. Few will deny the 15 or 20 per cent of medical bankrupts that Dr. Ault speaks of a chance at rehabilitation by means of surgery; but what constitutes intractability, and when does one decide that the disease has become irreversible? The barium enema and sigmoidoscopy are excellent guides. Likewise, medical complications such as severe anemia, arthritis, fecal incontinence, pyoderma and other toxic manifestations may suggest that medical management will be no longer effective. It has been pointed out, however, by many authors that neither the duration of the disease nor the character of the roentgen changes is an accurate criterion of a hopeless prognosis and that spontaneous remission may occur when one is about to give up.

In the interest of progress we may have to sacrifice an occasional spontaneous recovery or operate on a patient who might have done as well without the operation. Whether we are so inclined or not, we must embark on a period of earlier surgical intervention in order to learn whether a lower medical and surgical mortality may be achieved and perhaps also closure in a greater percentage of cases. Until such time, we should not hold out the promise of future closure when recommending ileostomy.

Dr. Clarence Dennis, Minneapolis: Between Jan. 1, 1934, and early 1946, 72 patients were treated nonsurgically at the University of Minnesota Hospitals, or surgical treatment was put off until all agreed that the outlook was hopeless. An effort was made in 1946 to contact all those alive; 25 could not be traced. The over-all known mortality was 40.3 per cent. The initial hospital mortality was 28 per cent. If one makes the assumption that those not followed or followed for only short periods thus far fared the same as those followed for longer periods, half were dead in five years and two thirds were dead in ten. The proportion considered improved after nonsurgical therapy is high in the first years, but it falls as the years pass, and of the 8 patients followed over ten years, only 1 is so classified. In this group of 8 patients 1 is now well only because a total colectomy was done for complicating cancer, and 2 of these and 1 of the five year group are well since they underwent vagotomy. In about the same period 41 patients were subjected to ileostomy or other direct surgical attack on the bowel, the period of postoperative observation ranging up to nine years. The initial mortality, in contrast to 28 per cent for the nonsurgical group, was 7.3 per cent. The over-all mortality was 24.6 per cent, a figure which is less disturbing under further scrutiny, for the deaths in 7 of the 10 cases were due to causes which are now preventable and if the cases were to be seen over again, the over-all mortality would be 7.3 per cent.

Five of the preventable surgical deaths were due to carcinoma of the involved colon. One of these occurred in a case considered at the time as successfully controlled on conservative management by another medical group; carcinomatosis was present, but obstruction dictated colectomy, which gave five months of life. Four patients were the victims of failure to remove the colon after ileostomy, the cancers therefore developing silently and killing in from one to nine years. In 2 additional cases the patients have undergone ileostomy and the colon is still in place; both have polyps and are unwell, and both refuse further surgical treatment. The other two preventable deaths were due to improper formation of an ileostomy opening and failure to employ prophylactic dicumarol therapy.

The surgical procedure which has proved most successful in saving life is ileostomy followed by single stage colectomy—to the rectum or including the rectum. There were 30 such colectomies performed in the period under discussion,

and many have been done since. None of these patients has died at the time of operation or since, save 1 who died of late complications of ileoproctostomy and 1 who died of carcinomatosis, as already mentioned. Twenty-two of the 30 are in good health; those who are not are in unsatisfactory condition because of proctitis or high enteritis and complications thereof or because of injudicious attempts to eliminate the ileostomy.

In the experience with the total of 113 cases mentioned, there have been 5 fatal cancers of the colon and 3 nonfatal ones; one of these was removed recently after symptoms, and 2 were found by the pathologist after routine removal of the colon. If one restricts attention to the cases with at least a five-year history of colitis, of which there were 53, the cancer rate was 15 per cent. The time of apparent onset of cancer was from nine to twenty-two years after the onset of colitis. If one is more precise and limits attention to those cases, both with and without cancer. in which there was a five-year period of observation by us, 18 per cent, essentially the same figure, is obtained.

Of the 53 patients with a five-year history of colitis, 7 had cirrhosis of the liver; also 1 patient died of cirrhosis after four years of colitis. In the five year group, therefore, including this exception, 15 per cent had cirrhosis, a point which Hoffbauer was first to make. Three of these patients had marked improvement of the cirrhosis after ileostomy or colectomy.

In the past two years, Dr. Frank Eddy, Dr. Austin McCarthy, Dr. Darrell Westover, Dr. Howard Frykman and I have been performing vagotomy in the therapy of ulcenative colitis. Thirty such procedures have been undertaken. There have been 2 surgical deaths, a rate lower than that for ileostomy, and 1 late death from unrelated causes. Twenty-five patients have been followed long enough for conclusions to be drawn, and 72 per cent are asymptomatic or improved at the present time. This is a procedure which should be used, for the present, only for the purpose of further evaluation. It is beset by many pitfalls, and the duration of the beneficial effect is not known. It is promising and relatively simple and safe, but it is not ready for general use.

Dr. Joseph B. Kirsner, Chicago: It seems to me that surgical intervention in 92 or 93 per cent of patients with ulcerative colitis is unusually high, if I have interpreted Dr. Dennis' discussion correctly. I think we are in agreement that stricture, obstruction, polyposis, carcinomatous degeneration and persistent anemia constitute definite indications for surgery in ulcerative colitis. However, in our experience, surgical treatment is required in only 10 to 20 per cent of patients.

Vagotomy for ulcerative colitis is perhaps a worth while experiment. Performed by careful observers, such as Dr. Dennis and his colleagues, under well controlled conditions, it may provide further knowledgs of the disease. However, I do not believe that the procedure should be employed indiscriminately; the results certainly should be evaluated most carefully. I have the impression that some of the patients subjected to vagotomy have had relatively mild disease. In our experience, it is possible to maintain these persons in a satisfactory state of health by careful medical management. I should add careful and patient medical management, with attention to the individual as a whole, the improvement of nutrition and the control of infection. The natural history of chronic ulcerative colitis is one of remissions and exacerbation. I hardly need emphasize, therefore, the importance of prolonged observation in the interpretation of results. I would be interested to know the duration of follow-up observation after vagotomy in the patients treated by Dr. Dennis.

In my opinion, the medical management of ulcerative colitis remains the treatment of choice in the majority of cases at the present time.

DR. GARNET W. AULT, Washington, D. C.: I like to feel that we should be conservative in recommending surgery in the treatment of ulcerative colitis, and I expect to maintain that attitude. However, once we embark on surgical treatment, I feel that we should be most radical to obtain satisfactory results. Dr. Bank mentioned impending perforation as an indication for surgery. At present I am not sure that we have any documented evidence which will enable one to establish a diagnosis of impending perforation.

Dr. Dennis has called attention to many controversial points. I believe they must be seeing seriously ill patients with ulcerative colitis at the University of Minnesota if they are required to operate in 92 or 93 per cent of their cases. For the present, I agree with Dr. Kirsner, who feels that vagotomy in the treatment of ulcerative colitis should be limited to the patients admitted to the University of Minnesota Hospital.

Once cancer of the colon has developed in ulcerative colitis the lesion is usually unresectable. Successful outcome from resection for ulcerative colitis with cancer has been recorded very few times; therefore, we must be alert in regard to those patients who have had polypoid degeneration. We must be further alert in observing patients who have undergone ileostomy, who are getting along well, who are gaining weight and who are apparently in good condition. In general, do not allow these patients to go indefinitely without colectomy if polypoid degeneration develops. If you do, you are doing an injustice to the operation you have previously performed because maligant degeneration will many times develop when the colon is left in indefinitely.

I am going to ask if Dr. Dennis could state the exact time of follow-up in the cases in which vagotomy was performed. This seems to be an interesting point.

DR. CLARENCE DENNIS, Minneapolis: There is nothing I fear so much as that physicians will decide that this is a panacea and should be used widely. That would bring repercussions which I am sure would result in the loss of a good many patients who might otherwise do nicely. I think this subject should remain under study until we have really the answer as to whether or not it is worth doing.

The first vagotomy for ulcerative colitis was done in October 1946. We have had much too short a time to draw conclusions on what the long term results are going to be. This is one of the most important reasons for not advising the widespread use of this procedure.

# DEGENERATIVE OSTEOARTHRITIS OF THE HIP JOINT

## Survey of Degenerative Arthritis Secondary to Aseptic Necrosis of the Femoral Head

THOMAS HORWITZ, M.D.
INDIANAPOLIS

THIS report is based on the study of 81 cases of degenerative osteoarthritis of the hip joint, of both the primary and the secondary type. Among these 81 cases, there were 16 in which the arthritis followed aseptic necrosis of the femoral head, due to a variety of causes. The purpose of this investigation is to discuss the pathology and pathogenesis of degenerative osteoarthritis against the background of these cases, and particularly to evaluate the procedures advocated for treatment of osteoarthritis of the hip joint.

## PRESENT OBSERVATIONS

### CLASSIFICATION AND PATHOGENESIS

Of the 81 cases of degenerative arthritis of the hip studied in this hospital, there was a group of 33 in which the cause was obscure. In another group, comprising 28 cases, the arthritis was secondary to congenital dislocation of the hip (3 cases), congenital subluxation of the hip (4 cases), direct trauma without fracture (5 cases), preexistent rheumatoid arthritis (7 cases), pyarthrosis (1 case), slipped capital epiphysis (7 cases) and a static disturbance of a normal hip secondary to a congenitally dislocated hip on the opposite side (1 case). In a third group, of 4 cases, without evidence of aseptic necrosis, there were 2 cases of the condition in caisson workers and 2 in which there was healed fracture of the femoral neck (figs. 1, 2, 3 and 4). Finally, in 16 cases the condition was clearly secondary to aseptic necrosis of the femoral head. These included 1 case of protracted osteochondrosis of the capital epiphysis of the femur (Legg-Calvé-Perthes disease); 2 cases of healed fracture and 2 cases of ununited fracture of the neck of the femur, 2 cases following traumatic dislocation of the femoral head, 1 case secondary to caisson disease, 3 cases of so-called idiopathic aseptic necrosis and 5 cases of severe displacement of the capital epiphysis of the femur (figs. 5 and 6). Some of these cases

The work was done under a Frederick Brown Research Fellowship in Orthopedic Surgery.

From the Laboratory Division, Hospital for Joint Diseases, New York; Henry L. Jaffe, M.D., Director.

have points of special interest. For example, in the case of Perthes' disease, a drilling operation had been performed in the early stage of the disorder, at the age of 4 years, and massive avascular necrosis of the entire femoral head had been demonstrated at a second operation, eight years later. It is perhaps worth noting that in 1 of the 3 cases of so-called idiopathic aseptic necrosis there had been a history of chills and fever two years prior to operation, at which time the presence of osteomyelitis had been suspected (fig. 5). In the 5 cases of severe

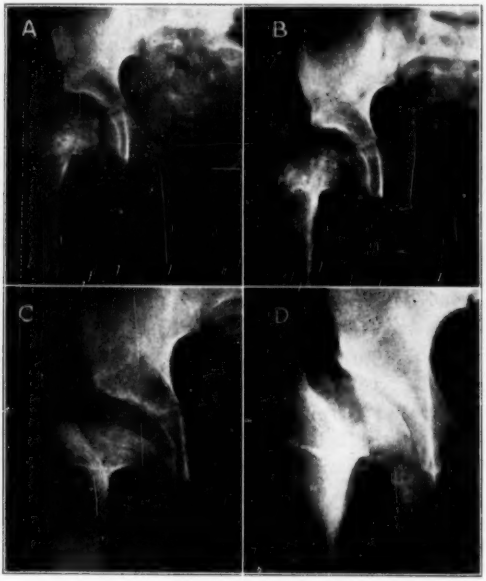


FIG. 1.—Anteroposterior roentgenograms of the right hip joint in a boy. *A*, taken when patient was 6 years of age, five months after a drilling operation intended to aid revascularization and healing of early Perthes' disease and eight months after onset of a slight limp.

*B*, appearance five months later, showing progression of the aseptic necrosis. The capital epiphysis of the femur is flattened and fragmented laterally and extends beyond the lateral margin of the acetabulum. The neck is widened and appears foreshortened.

*C*, taken when boy was 11, shows apparent healing of the original disease process. However, the capital epiphysis is greatly flattened and broad, extending out over the femoral neck superiorly to reach the great trochanter. The neck is broadened and distinctly foreshortened. The epiphysial line of the head appears regular.

*D*, taken when boy was 16, shows that the epiphysial line is closed. The bony structure of the upper end of the femur is of uniform density, and the articular surface appears smooth. A severe coxa vara is present, the result of several factors: retarded growth of the capital epiphysis, overgrowth of the great trochanter and almost complete absence of the neck. The eventual appearance of degenerative arthritis in the hip joint, secondary to deformation and incongruity of its bony components, is inevitable, and the patient had already manifested limp and some discomfort.

displacement of the capital epiphysis of the femur, the patients were between 13 and 16 years of age. Necrosis of the bone was incidental to vigorous attempts at manipulative reduction in 2 of these 5 cases, while in the other 3 it followed attempts at surgical correction.

### CLINICAL MANIFESTATIONS

Pain was the predominant complaint, although it was often preceded by limp for several years. It was usually felt in the groin and, because of the mixed nerve supply of the hip joint, was referred along the distributions of the obturator, sciatic and femoral nerves.

Limp was incidental to pain or deformity or to both. With proliferation of bone along the margins of the acetabulum and at the juncture of the head and neck of the femur, there were progressive loss of movement, especially of extension, abduction and internal rotation, and the development of deformities of flexion, adduction and external rotation. Secondary shortening depended on the degree of deformity of the hip and on whether there was loss of head and neck substance. The shortening was greatly exaggerated in cases of congenital dislocation of the hip and in cases of old, ununited fracture of the femoral neck. As fixation progressed, pain in the hip often diminished, although pain in the back sometimes complicated the deformity of the hip. Considerable

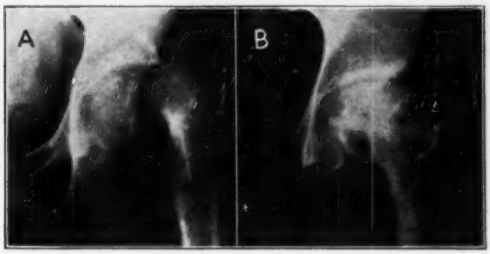


Fig. 2.—Anteroposterior roentgenograms of left hip joint in a youth. *A* was taken at the age of 14, when the patient had had pain in this joint for one and one-half years. There is severe downward and posterior displacement of the capital epiphysis in relation to the externally rotated neck. There was no histologic evidence of aseptic necrosis in the material resected some time later, during open relocation of the femoral head and its transfixion to the neck by an ivory peg.

*B*, a roentgenogram of the same hip, taken five years later, shows a deformed and enlarged femoral head, narrowed joint space, osteosclerosis of the head and of the superior portion of the acetabulum and several radiolucent areas in the head-neck region—evidence of secondary degenerative arthritis. The bone peg is still visible and is not fully incorporated into the host bone. The opposite hip (not illustrated) in this case, which had been the site of mild displacement of the capital epiphysis, showed spontaneous healing without evidence of any residual deformity or secondary degenerative changes in the joint five years later.

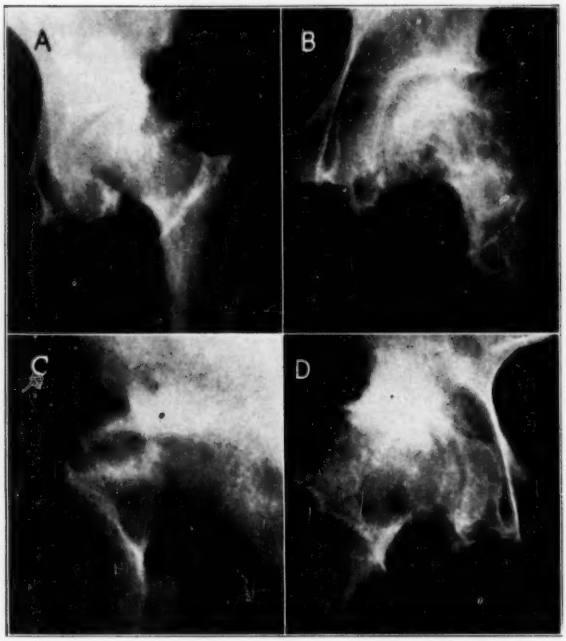


Fig. 3.—*A*, anteroposterior roentgenogram of the left hip in a woman aged 33, who had had pain in the hip for six years. There is extensive degenerative arthritis, as manifested by narrowing of the joint space, subchondral sclerosis of the femoral and acetabular components and cystification of the enlarged femoral head. The acetabulum is shallow and defective in depth. Whether this is an instance of a preexisting congenital dysplasia of the acetabulum with secondary degenerative arthritis could accurately be ascertained only by comparison with roentgenograms made earlier in life.

*B*, anteroposterior roentgenogram of the left hip joint in a man aged 59 with a history of fracture of the neck of the femur incurred three years previously and treated with a plaster hip spica, and with a painful hip of six months' duration. The neck is foreshortened and shows patchy sclerosis at the site of the healed fracture, and there is marginal bony proliferation at the juncture of the head and neck. Sections of material removed at the time of cheilotomy showed evidence of degenerative arthritis, but no aseptic necrosis.

*C*, roentgenogram of the right hip joint in a man aged 24 with a history of pain in the hip of two years' duration, three years after a fascial arthroplasty, at which time the head was merely trimmed and the acetabulum was deepened. There have been spontaneous resorption of more than one-half the remodeled head and neck and the development of a spontaneous shelf.

*D*, anteroposterior roentgenogram of the right hip joint of a man aged 56 with pain in both hips of several years' duration and with flexion–external rotation deformities and limitation of motion in all directions. The roentgenogram of the left hip joint showed changes identical with those in the joint illustrated. There is a degenerative arthritis with narrowing of the joint space (especially superiorly, where the bony elements are densified), hypertrophy of the femoral head and spur formation at the superior margin of the acetabulum. The bilaterally symmetric features, the age of the patient and the absence of any apparent underlying factor indicate that this case is an instance of the spontaneous, or primary, type of degenerative arthritis, probably on the basis of wear and tear or of senility.

restriction of motion in all directions was manifest in cases of intrapelvic protrusion of the hip or in cases secondary to infectious arthritis. In such cases there may be an abduction deformity.

## PATHOLOGIC OBSERVATIONS

Tissue for histologic study was available in all 81 cases. The changes noted in the articular cartilage varied from flaking and fibrillation to complete erosion of the weight-bearing portions (figs. 7 and 8). In some areas the altered cartilage showed irregularities in the number and distribution of the cells, in their staining properties and in the

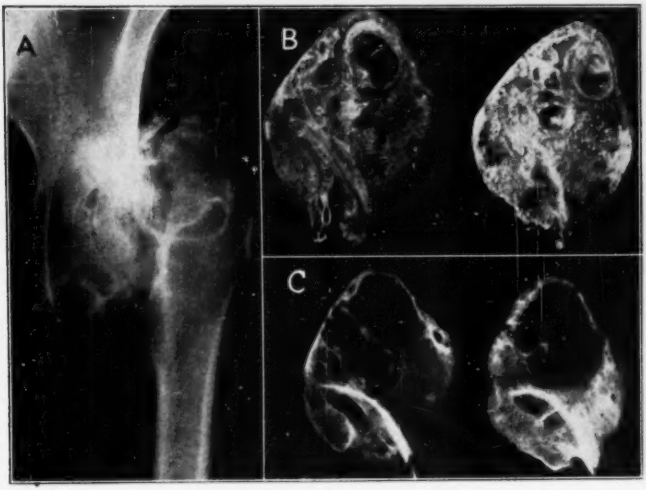


Fig. 4.—*A*, anteroposterior roentgenogram of the left hip joint in a woman aged 40 with a history of pain in the left hip for twelve years and in the right hip for three years. A diagnosis of congenital dislocation of the left hip had been made and surgical intervention advised a number of years before. Distinct degenerative changes are manifested by deformity of the femoral head, osteosclerosis and marginal proliferation of bone at the superior border of the acetabulum and encircling the femoral head. The initial impression is that the deformed head accurately occupies a shallow acetabulum, with enormous proliferation of bone at the lateral border of the head and neck. Actually, the original femoral head is displaced completely out of the acetabulum, which, in turn, is occupied by an enormous mass of new bone deposited on the medial, inferior and posterior portions of the original femoral head.

*B*, photograph of two ¼ inch (6 mm.) slivers, sectioned in the coronal plane and through the middle of the resected left femoral head. The original head is greatly altered and comprises the upper two thirds of the specimen, while the lower third represents an enormous exostosis, which extends inferiorly and merges with the thickened inferior border of the femoral neck. The articular cartilage of the misshapen and flattened head is completely eroded, with exposure of the underlying sclerotic bone. What cartilage remains is fibrillated and extensively modified. The substance of the head is extensively cystified.

*C*, roentgenograms of the slivers in *B*.

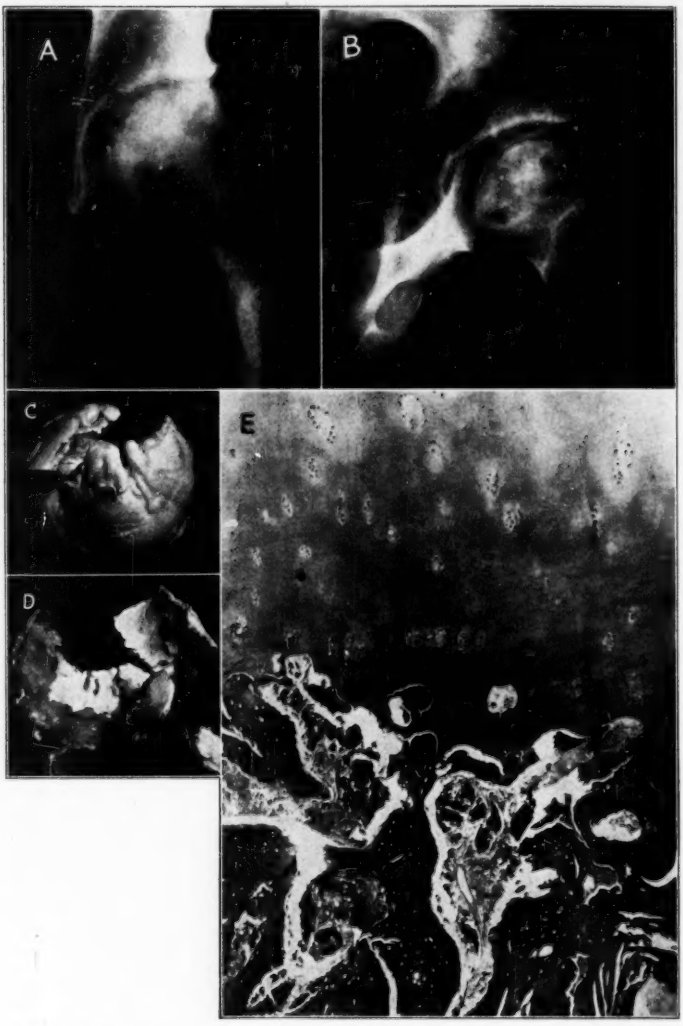


Fig. 5.—*A*, anteroposterior and, *B*, lateral roentgenograms of the hip joint in a youth aged 17, showing changes of aseptic necrosis in the femoral head. Planigrams showed more distinctly the wedge-shaped, demarcated area of sclerosis in the middle third of the head. The patient had had spontaneous and gradual onset of pain in the hip, without any injury, and, because of chills and fever, the early changes in the roentgenograms had been interpreted as those of osteomyelitis. *C*, and *D*, photographs of the articular surface of the femoral head, removed at arthroplasty. In *C*, the articular surface is extensively modified and presents

density of the matrix. In other places the degenerated cartilage was observed to have undergone fibrocartilaginous transformation. Wherever the articular cartilage was heavily modified but its calcified zone was still present, the latter was irregular, and even disrupted.

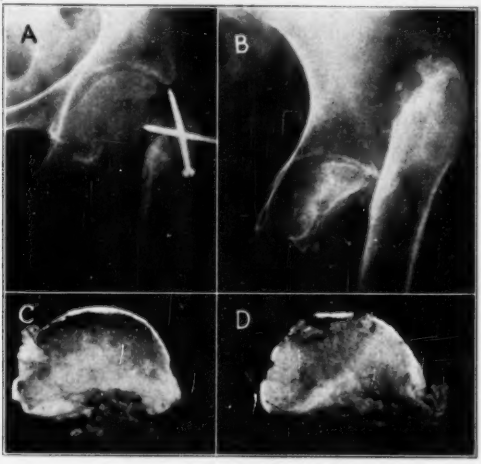


Fig. 6.—*A*, ununited fracture of the neck of the left femur in a woman aged 43 who had been injured two years previously; attempts at internal fixation and subtrochanteric osteotomy had been unsuccessful.

*B*, ununited fracture of the neck of the left femur in a woman aged 58, injured five years previously. The neck is almost completely resorbed, and the great trochanter is displaced upward. The capital fragment, removed at operation, showed extensive aseptic necrosis and degenerative articular changes.

*C*, coronal section of the femoral head in *A*, removed at reoperation, showing pronounced thinning and shredding of the articular cartilage, much fatty marrow in the head fragment and fibrous tissue at the site of nonunion. Microscopic sections revealed viable bone, no evidence of aseptic necrosis and degenerative changes in articular cartilage.

*D*, coronal section at the head fragment in a case of nonunion of the neck of the femur, showing advanced degeneration of the articular cartilage and a wedge-shaped area of aseptically necrotic bone.

Exostosis was a constant pathologic feature and contributed to the deformation of the bone ends of the joint. Marginally, larger or smaller exostoses ringed the articular end of the bones to variable degrees, and

furrows and folds, the results of collapse of the underlying subchondral necrotic bone. In *D*, the view of the under surface shows the central articular portion, which was necrotic and completely detached from the dense subchondral bone; the large cleft which transected the articular cap, and the subchondral sclerotic bone from the peripheral portions of the head, still attached to the cartilaginous surface. *E*, photomicrograph (× 15) of an area in the peripheral portion of this specimen, showing a viable, modified articular cartilage, extensive subchondral necrosis and marrow spaces filled with cartilage, bone debris and elements of dead marrow. There was no evidence anywhere, in all of the resected material, of any recent or old inflammatory process.

these exostoses were generally covered with modified articular cartilage. In addition, on the articulating surfaces occurred elevations and bumps, which could be designated as flat exostoses. These appeared in consequence of shifting and reduplication of the bone-cartilage border.

The subchondral bone trabeculae were compacted and thickened, especially where the articular cartilage was completely eroded, whereas the trabeculae more distant from the surface of the joint were thin and sparse. Identical changes were apparent in the contiguous surface of the

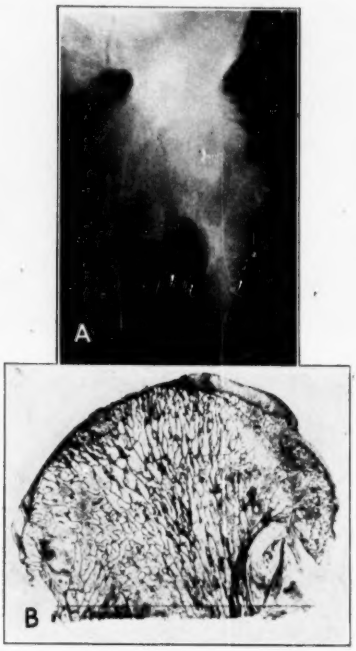


Fig. 7.—*A*, anteroposterior roentgenogram of the right hip joint in a man aged 40 with a history of pain of ten months' duration. The femoral head is enlarged and appears flattened; the joint space is narrowed, especially superiorly, and there is bony proliferation at the superior margin of the acetabulum. There is an adduction–external rotation deformity. This enlarged head resembles the mushroomed, flattened head seen in cases of untreated or inadequately treated Perthes' disease and of displacement of the capital epiphysis of the femur.

*B*, histologic section (slightly larger than actual size) of the femoral head and neck, removed at the time of surgical reconstruction. There is loss of articular cartilage in the central portion, associated with subchondral sclerosis. Deposit of new bone is manifest medially as a large, liplike exostosis and an adjacent bumplike excrescence on the surface of the head. This proliferation of bone medially and laterally, with loss of articular cartilage centrally, creates the impression of a flattened or mushroomed head.

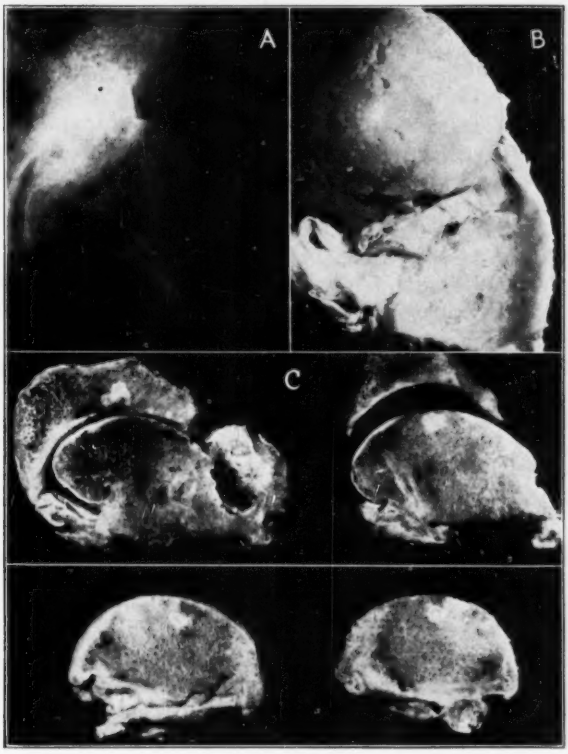


Fig. 8.—*A*, anteroposterior roentgenogram of the right hip joint in a woman aged 60 who died of melanomatosis. She had had severe pain in the right hip and groin for one year and gave a history of a fall two years previously. The femoral head is conspicuously flattened; the joint space is narrowed and seems obliterated superiorly, where the bony elements are densified; the femoral head appears cystified, and there is a large exostosis at the inferior part of the head.

*B*, gross specimen of the femoral head and part of the acetabulum removed at autopsy. Both cartilaginous surfaces show considerable degeneration. The center of the femoral head is devoid of all cartilage, and the underlying, eburnated bone is exposed.

*C*, four coronal sections through the hip joint, demonstrating the gross features of advanced degenerative arthritis. The left upper section is the most anterior, and the right lower is the most posterior section. One finds thinning or absence of articular cartilage on contiguous surfaces of the femoral head and acetabulum, subchondral osteosclerosis and areas of fibrosis (some of them cystified) replacing the osseous tissue on both sides of the joint. The large medial exostosis with its overlying articular cartilage, which is contiguous with that of the original femoral surface, appears to be a part of the femoral head, and this, along with the loss of cartilage over the central, weight-bearing portion of the head, creates an appearance of broadening, flattening and mushrooming.

acetabulum. The marrow of the femoral head was fatty or myeloid and was replaced in some areas with loose fibrous tissue. The development of cystlike cavities, which were sometimes observed in the femoral head and acetabulum, were due to degeneration in metaplastic cartilage in some cases, but were oftener caused by softening, and even liquefaction, of such areas of fibrosis in the subchondral region (figs. 7 and 8).

Collections of lymphocytes were seen in the marrow, and similar collections, some of them perivascular, were noted in the synovium. This observation is contrary to the findings of others,[1] who have emphasized the absence of these cells in degenerative arthritis. Indeed, I have observed such focal collections in the synovium in association not only with degenerative arthritis of the hip and knee joints, but with the neuropathic joints, nonspecific synovitis and a variety of other articular lesions.

Avascular necrosis of the subarticular bone is not an intrinsic part of the pathologic picture in hypertrophic or degenerative arthritis of the hip joint or of any other joint. However, it is in connection with the collapse and transformation of the femoral head associated with aseptic necrosis that one finds the most advanced manifestations of (secondary) osteoarthritis (fig. 5).

### ROENTGENOGRAPHIC FINDINGS

In roentgenograms, thinning and loss of articular cartilage were demonstrated by loss of joint space. The thickened and condensed subchondral bone was manifested as sclerosis, and there was corresponding densification of the acetabulum. The cystified areas appeared as subchondral areas of radiolucency. In those instances in which the head was enlarged, it often protruded from the lateral confines of the acetabulum, and in such cases there might be an osteophytic ledge at the lateral border of the acetabulum which somewhat compensated for the incongruity. However, true subluxation sometimes existed, the head being displaced laterally and the interval between its medial surface and the acetabulum being filled in by a reduplication of the acetabular fossa and by the medial beak of the enlarged femoral head. The combination of loss of articular cartilage over the weight-bearing portion of the head, deposition of bone at the head-neck juncture and widening of the neck by actual periosteal bone formation in the region of the neck produced a mushroom or cauliflower type of deformity which was not unlike that observed in untreated or inadequately treated Legg-Perthes disease, or displacement of the capital epiphysis of the femur (figs. 7 and 8). On the other hand, the head and neck of the femur

1. Allison, N., and Ghormley, R. K.: Diagnosis in Joint Disease: A Clinical and Pathological Study of Arthritis, Baltimore, William Wood & Company, 1931.

might protrude deep within the acetabulum in cases of secondary arthritis complicating protrusion of the acetabulum, the great trochanter approximating the superior border of the acetabulum in accordance with the degree of intrapelvic bulge of the medial acetabular wall. The femoral head might be somewhat enlarged by marginal proliferation of bone. In these cases, the head of the femur fitted snugly and appeared well molded within the acetabulum, the medial wall of which might become conspicuously thinned, or in occasional cases might appear thickened.

### TREATMENT

A variety of operative procedures were employed in the 65 cases of degenerative arthritis of the hip joint without underlying aseptic necrosis. While the follow-up records are not complete in all instances, there is sufficient evidence to indicate the deficiency of many of these procedures.

The femoral head was surgically reduced in size without the interposition of any medium in 9 cases, in 5 of which symptoms were not relieved. Autogenous fascial arthroplasty was performed in 11 cases, with failure in 5 cases and death as a result of postoperative infection in 1 case. In 9 cases, "vitallium" cup arthroplasty was done, with poor results in 8. Acetabuloplasty was performed in 5 cases, with 4 failures; drilling operation in 3 cases, with 2 failures; cheilotomy in 2 cases, with 1 failure (result unknown in the other), and bone block in 1 case, with failure. Resection of the head and neck of the femur was done in 3 cases, with partial relief of pain in 1 case and death one month after operation in 1 case; in 1 case the operation was too recent to permit evaluation of the results. The results of arthrodesis were more encouraging. Of 22 cases, solid fusion with relief of symptoms occurred in 15 and failure of fusion in 3, and no follow-up results were available in 4 cases. The results were uniformly poor after seven reoperations and good after five reoperations, in which arthrodesis terminated in fusion. In 1 of these cases, four operations were performed for the relief of pain: a bone block, a "vitallium" cup arthroplasty, a resection of the obturator nerve and, finally, arthrodesis.

Because of incomplete statistical data, no conclusions are justified from an analysis of the 16 cases in which the degenerative arthritis was clearly secondary to aseptic necrosis of the femoral head. In the 2 cases of ununited fracture of the neck of the femur and in the 1 case of so-called idiopathic aseptic necrosis, operation was too recent at the time of this study to permit evaluation of results. In the case of protracted Legg-Perthes disease, the 5 cases of severe displacement of the capital epiphysis of the femur and the case in which aseptic necrosis occurred on the basis of caisson disease, progress was not favorable after several types of reconstructive operations on the hip joint. In the

2 cases of healed fracture of the femoral neck with degenerative arthritis secondary to aseptic necrosis of the fragment of the head, fusion operations were carried out, and arthroplasty was performed in the remaining 4 cases—2 cases of so-called idiopathic aseptic necrosis and 2 secondary to traumatic dislocation of the femoral head. In no instance in this group in which arthroplasy was performed was a "vitallium" cup or any other type of cup used as an interposing medium.

## PREVIOUS OBSERVATIONS

### PATHOGENESIS

The literature dealing with degenerative arthritis gives a great deal of attention to the question of pathogenesis.[2] It is clear that in certain instances arthritis of the hip joint is primary. Plewes [3] determined an underlying cause in only 51 per cent of 242 cases; Harmon [4] inculpated a known causative factor in only 39.4 per cent of his series, while Wiberg [5] classified 46.7 per cent of his 257 cases as instances of "secondary" arthritis. The spontaneous form may not be as common as it is usually thought to be. In the present series, the degenerative arthritis was definitely superimposed on a preexisting lesion of the hip joint in 48 of the 81 cases (59 per cent).

As demonstrated by Plewes [3] in cases of displaced capital epiphysis and of Perthes' disease, secondary arthritis will appear earlier when the primary condition has been of late onset (figs. 1 and 2).

It has been observed that incongruity of articular surfaces is most striking in cases of congenital dislocation and congenital subluxation of the femoral head, conditions which may be further complicated by vascular changes in the capital epiphysis incidental to closed or open

2. (*a*) Allison and Ghormley.[1] (*b*) Nichols, E. H., and Richardson, F. L.: Arthritis Deformans, J. M. Research **21**:149-222, 1909. (*c*) Dawson, M. H.: Chronic Arthritis, in Nelson Loose-Leaf Living Surgery, New York, Thos. Nelson & Sons, 1935, pp. 605-644. (*d*) Keefer, C. S.: The Pathogenesis and Diagnosis of Degenerative Arthritis, M. Clin. North America **18**:947-967, 1935. (*e*) Collins, D. H.: Pathology of Osteoarthritis, Brit. J. Rheumat. **1**:248-262, 1939. (*f*) Bauer, W.: Studies Pertaining to the Origin and Nature of Hypertrophic Arthritis, Tr. & Stud. Coll. Physicians, Philadelphia **7**:1-20, 1939. (*g*) Sawyer, M. H., and Ghormley, R. K.: Pathologic Study of Hypertrophic Arthritis of the Hip, Surgery **9**:381-393, 1941. (*h*) Phemister, D. B.: Etiology and Pathology of Degenerative Hip Disease, in American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems, Ann Arbor, Mich., Edwards Bros., Inc., 1947, pp. 189-198.

3. Plewes, L. W.: Osteoarthritis of the Hip, Brit. J. Surg. **27**:682-695, 1940.

4. Harmon, P. H.: Arthroplasty of the Hip for Osteoarthritis Utilizing Foreign-Body Cups of Plastic, Surg., Gynec. & Obst. **76**:347-365, 1943.

5. Wiberg, G.: Studies on Dysplastic Acetabula and Congenital Subluxation of the Hip Joint, with Special Reference to the Complication of Osteoarthritis, Acta chir. Scandinav. (supp. 58) **83**:1-134, 1939.

reduction, and in cases of congenital dysplasia (undervelopment) of the acetabular roof without displacement of the femoral head (figs. 3*A* and 4). However, Wiberg [5] placed too much emphasis on dysplasia of the acetabulum in the development of secondary arthritis when he attributed the condition in 25.7 per cent of his 257 cases to this origin. Plewes demonstrated that, although the acetabulum appeared shallow in most of his cases, actual measurements showed that the decrease in depth was caused by deposition of new bone on the medial wall of the acetabulum. Articular incongruity was also observed in cases of coxa vara on a congenital, metabolic or traumatic basis and in cases of protrusion of the acetabulum.

Pommer suggested that the normal use of a joint through a life of average length, without definite trauma or infection, may result in evidences of wear and tear as an expression of senescence. The observations of Heine [6] and Beitzke [7] suggested that some degree of osteoarthritis is universal after the age of 50, and the studies of Bauer and his co-workers [2f] revealed that degenerative articular changes become increasingly manifest with each decade of life and are the result of increasing age and continued use. In similar anatomic studies, Meyer [8] referred to these lesions as "attritional." Static defects in the spine and lower extremities which alter the mechanics of weight bearing influence the time of appearance and the severity of secondary arthritis of the hip. It becomes especially manifest in joints subjected to repeated occupational injury (fig. 3*D*).

The lesion of secondary degenerative arthritis cannot be differentiated histologically from that of primary traumatic arthritis. Key [9] showed that an osteoarthritis may develop experimentally through a variety of means which injure or destroy the articular cartilage. This observation is consistent with the finding of degenerative arthritis as a complication of intra-articular fractures, internal joint derangements and intra-articular foreign metallic bodies. In my material, the capital fragment in 2 cases of ununited fracture of the femoral neck, even though viable and without histologic evidence of aseptic necrosis, manifested pronounced degenerative changes in the articular cartilage. Such changes could vitiate the results of reconstructive procedures which aim to preserve the apparently viable capital fragment, as in subtrochanteric (trans-

6. Heine, J.: Ueber die Arthritis deformans, Virchows Arch. f. path. Anat. **260**:521-663, 1926.

7. Beitzke, H.: Ueber die sogen. Arthritis deformans atrophica, Ztschr. f. klin. Med. **74**:215-229, 1912.

8. Meyer, A. W.: The Minuter Anatomy of Attritional Lesions, J. Bone & Joint Surg. **13**:341-360, 1931.

9. Key, J. A.: Experimental Arthritis. The Changes in Joints Produced by Creating Defects in the Articular Cartilage, J. Bone & Joint Surg. **13**:725-739, 1931.

location) osteotomy, bone grafting, with or without internal metallic (nail) fixation, and the Brackett type of reconstruction. Thus, the wisdom of examining the articular surface of the head fragment prior to these procedures becomes apparent (fig. 6). When the articular surface is found to be extensively modified, one of the reconstructive procedures which entails removal of the capital fragment or an arthrodesis would appear to be indicated.

*Aseptic Necrosis of the Femoral Head as the Basis of Secondary Degenerative Arthritis.*—That the femoral head is particularly susceptible to the occurrence of aseptic necrosis is attributable to the vulnerability of the blood supply to interruption by traumatic and disease processes.[10] Necrosis may follow traumatic dislocation of the femoral head or fracture of the femoral neck (with or without subsequent union) (fig. 6). Indeed, Boyd and George [11] reported the occurrence of aseptic necrosis and complicating degenerative arthritis in a surprisingly high percentage of cases of femoral neck fractures observed from one to two or more years after injury, despite good bony union.

Aseptic necrosis may appear not only in connection with pronounced spontaneous displacements of the capital epiphysis of the femur (so-called slipped epiphysis), but after vigorous attempts at manipulative reduction or recontructive operations, such as osteotomy of the femoral neck or arthroplasty. However, necrosis is uncommon in connection with displacement of the capital epiphysis of the femur.[12] As has been observed by Phemister and his co-workers,[13] among others, aseptic necrosis of the femoral head may also appear in caisson workers,

10. Phemister, D. B.: Repair of Bone in the Presence of Aseptic Necrosis Resulting from Fractures: Transplantations and Vascular Obstruction, J. Bone & Joint Surg. **28**:769-787, 1930; Fractures of the Neck and Femur, Dislocations of Hip, and Obscure Vascular Disturbances Producing Aseptic Necrosis of the Head of Femur, Surg., Gynec. & Obst. **59**:415-440, 1934; Changes in Bones and Joints Resulting from Interruption of Circulation: I. General Considerations and Changes Resulting from Injuries, Arch. Surg. **41**:436-472 (Aug.) 1940; II. Nontraumatic Lesions in Adults with Bone Infarction; Arthritis Deformans, ibid. **41**:1455-1482 (Dec.) 1940.

11. Boyd, H. B., and George, I. L.: Complications of Fractures of the Neck of Femur, J. Bone & Joint Surg. **29**:13-18, 1947.

12. Jaffe, H. L., in Pomeranz, M. M.: Epiphyseolysis or Separation of the Capital Epiphysis of the Femur in Adolescence, Am. J. Roentgenol. **40**:580-597, 1938. Moore, R. D.: Aseptic Necrosis of the Capital Femoral Epiphysis Following Adolescent Epiphyseolysis, Surg., Gynec. & Obst. **80**:199-204, 1945.

13. Kahlstrom, S. C.; Burton, C. C., and Phemister, D. B.: Aseptic Necrosis of Bone: I. Infarction of Bones in Caisson Disease Resulting in Encapsulated and Calcified Areas in Diaphyses and in Arthritis Deformans, Surg., Gynec. & Obst. **68**:129-146, 1939; II. Infarction of Bones and Undetermined Etiology Resulting in Encapsulated and Calcified Areas in Diaphyses and in Arthritis Deformans, ibid. **68**:631-641, 1939. Kahlstrom, S. C., and Phemister, D. B.: Bone Infarcts: Case Report with Autopsy Findings, Am. J. Path. **22**:947-953, 1946.

although identical changes have been observed in the femoral head of persons who have never been caisson workers.[14]

Freund [15] also called attention to cases of aseptic necrosis of the femoral head for which no cause was apparent. He saw an analogy between these lesions and osteochondritis dissecans of the knee. I, too, have observed 3 cases which seemed to belong to this category (fig. 5). However, the roentgenogram of the lesion in such cases tends to be somewhat different from that of osteochondritis dissecans. Specifically, in contrast to osteochondritis dissecans of the knee, the lesion in the femoral head is not clearly demarcated from the surrounding bone. Furthermore, in these cases of femoral aseptic necrosis, the necrotic, and only suggestively demarcated, focus is likely to become reconstituted and reunited in its bed.

If an area of aseptically necrotic bone is attached to and directly continuous with living bone, there is ingrowth of vessels, connective tissue and osteogenic elements from the viable bone, and the dead bone is gradually resorbed and replaced by new bone ("creeping substitution"). Pathologic fracture may occur between the dead and the living portion and result in collapse and delayed union or nonunion.[16] The process of bone replacement may become "arrested prematurely" before its completion [17]; for this reason, even early recognition and the most judicious measures of protecting the affected area may fail to prevent collapse and deformity. That residual islands of dead bone may be present years after the clinical conclusion in Perthes' disease was observed histologically by Bergmann [17b] and suggested by Sutro [18] on the basis of roentgenographic findings.

Necrotic bone appears more opaque in the roentgenogram than the viable bone about it. Alterations in density result from atrophy of disuse, creeping replacement of dead bone by new, viable bone, pathologic fractures and collapse of dead bone bordering on joints, compression of dead trabeculae and infiltration of "bone sand" into the dead marrow spaces. However, if the process of resorption of the original bone keeps pace with the formation of new bone, such sclerosis may not be evident.

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14. Taylor, H. K.: Aseptic Necrosis and Bone Infarcts in Caisson and Noncaisson Workers, New York State J. Med. **43**:2390-2398, 1943.

15. Freund, E.: Osteochondritis Dissecans of the Head of the Femur: Partial Idiopathic Aseptic Necrosis of the Femoral Head, Arch. Surg. **39**:323-352 (Sept.) 1939.

16. Sherman, M. S., and Phemister, D. B.: The Pathology of Ununited Fractures of the Neck of the Femur, J. Bone & Joint Surg. **29**:19-40, 1947.

17. (*a*) Phemister.[10] (*b*) Bergmann, E.: The Role of Aseptic Bone Necrosis in Hip Lesions, Am. J. Surg. **63**:218-235, 1944.

18. Sutro, C. J., and Pomeranz, M. M.: Perthes' Disease, Arch. Surg. **34**: 360-376 (Feb.) 1937.

In aseptic necrosis, the nutrition of the articular cartilage becomes affected if the underlying bone is not soon replaced by normal bone. In cases of long standing, therefore, degenerative arthritis supervenes, and these changes become exaggerated with collapse and deformity of the femoral head—changes which occur when the unrecognized lesion is unprotected from weight bearing, or unfortunately, even when protective measures have been instituted in those instances in which the process of reorganization has become "arrested." Indeed, even when the form of the femoral head is well preserved, the new articular fibrocartilage may be so imperfect that the development of a secondary degenerative arthritis is inevitable. Bergmann [17b] stated that certain of his cases demonstrated the effect of constant irritation of the synovial membrane by gradual passage of necrotic powdered material, including spicules of bone and debris, into the joint space through an aperture in the articular cartilage. I, too, have observed such bony debris ground into the synovial membrane at, or close to, the capsuloarticular junctures.

### TREATMENT

The importance of early and adequate treatment of congenital deformities of the hip joint and of disease and traumatic lesions of the hip joint which may be followed by deformity and incongruity of this joint cannot be overemphasized. On such treatment depends the prevention of the early appearance of the more advanced stages of secondary degenerative arthritis. With adequate early treatment, changes in the joints which may occur will be less severe and will appear later in life. With patients who are not required to be on their feet for long periods, a program of conservative therapy—traction, external fixation and physical therapy—may suffice to ameliorate the symptoms. But in patients who must return to an active life, entailing considerable weight bearing, the end results of conservative management are unsatisfactory.

In the light of pathologic alterations in degenerative arthritis of the hip joint, it is not difficult to understand why many of the procedures which have been recommended for the surgical therapy of this lesion have given unsatisfactory results. Drilling of the head and neck of the femur,[19] implantation of a bone graft [20] and use of a muscle flap trans-

19. Smith, N.: Bone Drilling in the Neighborhood of Inflamed Joints and Elsewhere, Brit. M. J. **1**:416-417, 1890. Mackenzie, J. F.: On the Deliberate Opening of Bones as a Treatment for Rheumatoid Arthritis, M. J. Australia **2**: 690-691, 1932; Osteoarthritis of the Hip and Knee: Description of Surgical Treatment, Brit. M. J. **1**:306-308, 1936. Simpson, W. C.: Painful Osteoarthritis of the Hip: A Surgical Treatment, Proc. Staff Meet., Mayo Clin. **12**:577-579, 1937.

20. Graber-Duvernay, J.: Un traitement nouveau de l'arthrite chronique de la hanche: Le forage de l'épiphyse fémorale, J. de méd. de Lyon **13**:531-540, 1932.

plant into the femoral neck,[21] as measures of "revascularizing" the femoral head, have not proved sound procedures. That improvement following drilling, when it does occur, is often transitory has been recently reported by a proponent of this procedure.[22] The histologic sections from several cases of Perthes' disease of degenerative arthritis treated by multiple drillings indicate that such drill holes persist for years, become filled with connective tissue and in no way modify the progress of these disease processes. Nor is it clear how a piece of transplanted bone, avascular in itself, or a muscle flap can help in the process of revascularization. Jaffe,[23] in unpublished experiments, observed that muscle transplants into the marrow cavity of long bones in laboratory animals underwent fibrosis.

Cheilotomy,[3] in which marginal excrescences are removed, does not serve to increase the adaptability of the altered femoral head within the acetabulum. Experience with partial resection of the acetabulum[24] has not been satisfactory, and this procedure is no longer employed by its original proponent in this country.[25] Subtrochanteric osteotomy,[26] which theoretically serves to alter the lines of weight bearing and to rotate the femoral head, fails to modify the essential lesions of the hip in any way. Relief in a series of 15 patients thus treated, with adequate follow-up records, which I have studied, was not uniform and, when it was secured, was often transitory. The bone block[27] attempts to relieve pain by limiting abduction in a condition which is characterized by progressive adduction deformity, and it does not alter the pathologic lesion or its progress.

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21. Venable, C. S., and Stuck, W. G.: Muscle-Flap Transplant for the Relief of Painful Monarticular Arthritis (Aseptic Necrosis) of the Hip, Ann. Surg. **123**:641-655, 1946.

22. Henderson, M. S.: Bone Drilling in Osteo-Arthritis of the Hip, in American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems, Ann Arbor, Mich., Edwards Bros., Inc., 1947, p. 223.

23. Jaffe, H. L.: Personal communication to the author.

24. (*a*) Hey-Groves, E. W.: Surgical Treatment of Osteoarthritis of the Hip, Brit. M. J. **1**:3-5, 1933. (*b*) Smith-Peterson, M. N.: Treatment of Malum Coxae Senilis, Old Slipped Upper Femoral Epiphysis, Intrapelvic Protrusion of the Acetabulum and Coxa Plana by Means of Acetabuloplasty, J. Bone & Joint Surg. **18**:869-880, 1936.

25. Smith-Peterson, M. N.: Cup Arthroplasty, read before the Section on Orthopedic Surgery, New York Academy of Medicine, March 21, 1947.

26. McMurray, T. P.: Osteoarthritis of the Hip Joint, J. Bone & Joint Surg. **21**:1-11, 1939.

27. L'Episcopo, J. B.: Bone Block for Painful Hips, J. Bone & Joint Surg. **20**:901-911, 1938.

While some investigators[28] have obtained good results with arthroplasty using autogenous fascia, others have failed to do so. The possibility of gradual resorption of the remodeled head and neck has been emphasized[29] (fig. 5*E*). Use of the "lucite" cup (Harmon[4]) showed that resorption of the neck also occurs after cup arthroplasty, and, in the case of use of the "vitallium" cup, favorable reports of which have been submitted by Smith-Peterson[30] and others,[31] descent of the cup on the greater trochanter indicates this complication. It is difficult to remove all of the diseased subchondral tissue in advanced degenerative arthritis and yet to leave sufficient head and neck not to compromise the mechanics of the new hip joint or to avoid the possibility of secondary aseptic necrosis. In addition, the remaining central portion of the neck is not particularly suited architecturally to bear the brunt of weight bearing, especially in cases of degenerative arthritis, in which the bone at a distance from the articular surface is always atrophic (fig. 8*B*). For these reasons, arthroplasty does not appear to be a suitable procedure in the treatment of advanced degenerative arthritis of the hip joint. However, Badgley[31c] reported good results in 50 per cent of cases after "vitallium" cup arthroplasty when the technical principles described by Smith-Peterson were rigidly observed.

Obturator neurectomy[32] for partial desensitization of the hip joint, and complete denervation of this joint by division of its obturator, femoral and sciatic nerve supply[32a] or by rhizotomy of the lumbar nerves,[33] in addition to not uniformly relieving the pain of osteoarthritis, may not even be without ill effect, in the light of the experi-

28. (*a*) Hallock, H.: A Study and End Result Report of Seventy Arthroplasties and Reconstruction Operations on the Hip Joint, Surg., Gynec. & Obst. **68**:106-112, 1939. (*b*) Smith, H., in discussion on Baker, L. D., and Waters, C. H.: Vitallium Cup Arthroplasty of the Hip, Arch. Surg. **44**:531-539 (March) 1942.

29. Phemister.[10] Hallock.[28a]

30. Smith-Peterson, M. N.: Arthroplasty of the Hip: A New Method, J. Bone & Joint Surg. **21**:269-288, 1939; footnote 25.

31. (*a*) Baker, L. D., and Waters, C. H.: Vitallium Cup Arthroplasty of the Hip, Arch. Surg. **44**:531-539 (March) 1942. (*b*) Becker, W. H.: Cup Arthroplasty of the Hip, Proc. Staff Meet., Mayo Clin. **19**:561-568, 1944. (*c*) Badgley, C. E.: Arthroplasty of the Hip for Degenerative Hip Disease, in American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems, Ann Arbor, Mich., Edwards Bros., Inc., 1947, pp. 207-222.

32. (*a*) Cottini, G. F.: El tratamiento del dolor en la artrosis deformante de cadera por la neurotomia del obturador (operación de Selig), Rev. Asoc. méd. argent. **59**:884-891, 1945. (*b*) Mallet-Guy, P., and de Mourgues, G.: Arthrite chronique de la hanche traitée par section endopelvienne du nerf obturateur, Lyon chir. **37**:262-264, 1941-1942.

33. Karlen, A.: Division of Fourth Lumbar Nerve Roots in Treatment of Arthritis Deformans of Hip, Acta chir. Scandinav. **90**:410-418, 1944.

mental work of Corbin and Hinsey.[34] These authors produced neuroarthropathies of the hip joint by section of the lumbosacral dorsal nerve roots and lumbar sympathectomy in animals whose activities were unrestricted. However, good results have been claimed after section of the obturator nerve for the relief of pain following arthroplasty, while the total denervation operation was recommended by Tavernier[35] for the relief of pain in adults with congenital dislocation of the hip, either alone or in conjunction with other operations.

Arthrodesis[36] has been offered as a dependable method of achieving a painless, stable joint in the treatment of unilateral degenerative arthritis of the hip joint, and the follow-up study in the present cases sustains this view. Methods of arthrodesis vary, but are clearly not always reliable in securing bony fusion, largely because of the difficulty of accurate postoperative fixation, which must often be prolonged. The combination of arthrodesis with nail fixation in one stage,[37] or in two stages, as advocated by Watson-Jones[36b] and by Haggart,[36g, h] may be the answer to this problem. While extra-articular fixation of the hip joint by means of a three-flanged nail alone has been suggested in cases in which surgical fusion cannot be tolerated, particularly in cases of obese patients,[38] it should be recognized, as it is by the proponents of this procedure, that the existing deformity will persist, that motion will not be completely eliminated and that pain may not be completely

34. Corbin, K. B., and Hinsey, J. C.: Influence of the Nervous System on Bone and Joints, Anat. Rec. **75**:307-317, 1939. Corbin, K. B.: Alterations in the Hip Joint After Deafferentation, Arch. Surg. **35**:1145-1158 (Dec.) 1937.

35. Tavernier, L.: Le traitement des luxations congénitales invétérées de la hanche, Rev. orthop. **32**:109, 1946; abstracted, Internat. Abstr. Surg. **84**:365-368, 1947.

36. (*a*) Henderson, M. S., and Pollock, G. A.: Surgical Treatment of Osteoarthritis of the Hip Joint, J. Bone & Joint Surg. **38**:923-931, 1940. (*b*) Watson-Jones, R.: Arthrodesis of the Osteoarthritic Hip, J. A. M. A. **110**: 278-280 (Jan. 22) 1938; (*c*) Discussion on Treatment of Unilateral Osteoarthritis of the Hip Joint, Proc. Roy. Soc. Med. **38**:363-368, 1944. (*d*) Bosworth, D. M., in discussion on Harmon.[4] (*e*) Schumm, H. C., in discussion on Harmon.[4] (*f*) Karlen, A.: A Clinical Study of Arthrodesis for Arthritis Deformans of the Hip Joint, Acta chir. Scandinav. (supp. 96) **91**:1-191, 1944. (*g*) Haggart, G. E.: Degenerative Arthritis of the Hip Joint Treated by One or Two Stage Arthrodesis with Metal Fixation (Watson-Jones), J. A. M. A. **128**:502-506 (June 16) 1945; (*h*) Degenerative Disease of the Hip Joint Treated by Arthrodesis, in American Academy of Orthopaedic Surgeons Lectures on Regional Orthopedic Surgery and Fundamental Orthopedic Problems, Ann Arbor, Mich., Edwards Bros., Inc., 1947, pp. 201-206.

37. Dickson, J. A., and William, L. J.: Arthrodesis of the Hip Joint in Degenerative Arthritis: A Modified One-Stage Procedure with Internal Fixation, J. Bone & Joint Surg. **45**:687-696, 1947.

38. Watson-Jones.[36b] Burns, B. H.: Fixation of the Osteoarthritic Hip by Nailing, Lancet **1**:978-980, 1939.

relieved or progressive deformity prevented thereby. For this reason, the latter procedure should be reserved for cases in which there is only a little residual, and painful, motion. Indeed, when surgical arthrodesis is combined with nail fixation, additional external fixation is necessary. In an attempt to secure some degree of fusion, which the extra-articular nail alone does not assure, Patrick [39] utilized a fibular graft in addition to the nail, both being inserted through the lateral aspect of the femur. This procedure is similar to that recommended by Harris [40] for arthrodesis of the hip joint. The ischiofemoral graft–subtrochanteric osteotomy advocated by Brittain [41] will, in addition to its theoretic advantages over other methods of arthrodesis, allow for the simultaneous correction of a resistant adduction deformity. To overcome the vicious action of the powerful adductor muscles of the thigh, Pease [42] suggested the use of section of the obturator nerve by the intrapelvic route as a supplementary procedure to arthrodesis.

The conservative management of aseptic necrosis of the femoral head consists in protecting the affected part from direct weight bearing until the head has become fully revivified. In cases in which the process remains static or is progressive, surgical measures must be resorted to. Despite reports of good results following the use of "vitallium" cup arthroplasty in the treatment of aseptic necrosis of the femoral head,[43] on the basis of the pathologic observations in these cases, this procedure does not appear wise. This conclusion appears to be sustained by the clinical experience of Pridie [44] and associates. An appreciation of the extent of the lesion, which may affect the entire femoral head and much of the neck, and of the tardiness and occasional incompleteness of its replacement by normal osseous tissue, makes it evident that such a head, remodeled surgically, cannot be expected to sustain the functions of a hip joint normally and that it may collapse. As Bergmann [17b] suggested, an aseptically necrotic femoral head should

39. Patrick, J.: Pin and Graft Arthrodesis for Osteoarthritis of the Hip, Lancet **2**:9-11, 1946.

40. Harris, R. J.: Arthrodesis of the Hip Joint: A New and Simple Operation, S. Clin. North America **23**:1412-1428, 1943.

41. Brittain, H. A.: Architectural Principles in Arthrodesis, Baltimore, Williams & Wilkins Company, 1942.

42. Pease, C. N.: Fusion of the Hip in Children: Chandler Method, read before the Fourteenth Annual Meeting of the American Academy of Orthopaedic Surgery, Chicago, Jan. 25-30, 1947.

43. Badgley.[31e] Smith-Peterson, M. N.; Larson, C. B.; Aufranc, O. E., and Law, W. A.: Complications of Old Fractures of the Neck of the Femur: Results of Treatment by Vitallium-Mold Arthroplasty, J. Bone & Joint Surg. **45**:41-48, 1947.

44. Girdleston, G. R.; Watson-Jones, R.; Stamm, T. T., and Pridie, K. H.: Discussion on Treatment of Unilateral Osteoarthritis of the Hip-Joint, Proc. Roy. Soc. Med. **38**:363-368, 1945.

be considered as an autogenous bone graft, which can be revivified only from the surrounding viable bone. How better to secure this replacement than by exposing the diseased femoral head to revitalization, not only from the neck side but from the acetabular side as well, as in arthrodesis? It would appear that arthroplasty, if truly necessary, should be deferred until the necrotic head is fully reconstructed.

Cases in which degenerative arthritis of the hip joint is bilateral pose a special problem. The condition is usually more advanced and painful on one side, and it is possible that surgical fusion of the joint on that side might lessen the burden on the less affected side and thus retard the progress of the condition there. If the opposite hip must be treated, arthroplasty is considered the procedure of choice, and in this country the "vitallium" cup procedure is most favored at this time. The procedure of pseudarthrosis (Girdlestone [44] and co-workers) and of resection of the head and neck (Hey-Groves [24a]) have met with considerable success in the hands of certain British surgeons. Plewes [3] reported remarkable results following excision of the head and neck of the femur, for he observed complete relief of pain in 20 of 23 cases and diminished pain after operation in 3, with stable joints in all cases at the end of two years and an average shortening of only 1⅝ inches (41 mm.). Stamm and associates [44] modified this procedure by adding to it a Schanz type of osteotomy, the shaft being placed at right angles to the intertrochanteric line, so as to restore the abductor mechanism and to give motion in a horizontal axis, both procedures being performed in one stage. Batchelor [45] employed the Schanz type of osteotomy six to eight weeks after excision of the femoral head and neck and avoided the use of external fixation by fixing the fragments effectively with a metallic plate. There have been sporadic case reports on this procedure in this country. Milch [46] employed a Lorenz type of osteotomy, followed by resection of the head and neck at a second stage, and reported the results in 1 case. Blount [47] illustrated with a case in which he performed a resection of the neck, so as to create a pseudarthrosis, and a subtrochanteric osteotomy, followed by effective fixation with a blade plate, at the same operation.

## SUMMARY

Degenerative arthritis of the hip joint was studied in 81 cases. One cause, or a combination of causes, was found in some cases. In other

45. Batchelor, J. S.: Excision of the Femoral Head and Neck in Cases of Ankylosis and Osteoarthritis of the Hip, Proc. Roy. Soc. Med. **38**:689-690, 1945.

46. Milch, H.: Resection of the Femoral Neck and Pelvic Support Osteotomy for Ankylosis of the Hip, Surgery **13**:55-61, 1943.

47. Blount, W.: Blade-Plate Internal Fixation for High Femoral Osteotomies, J. Bone & Joint Surg. **41**:319-339, 1943.

cases, degenerative arthritis seemed to occur spontaneously, without any apparent underlying cause.

The pathologic anatomy as observed in these cases was the same whether the degenerative arthritis appeared spontaneously or as a complication of, or sequel to, other lesions of the hip joint. Proliferation of bone at the juncture of the head and neck of the femur and denudation of the articular surface of the weight-bearing portion of the femoral head produced a flattened, mushroom-like head, not unlike the residual deformity in Legg-Perthes disease and in displacement of the capital epiphysis of the femur. Deformity of the head of the femur and thickening of the femoral neck as the result of the periosteal deposition of bone accounted for the roentgenographic and clinical features of degenerative arthritis of the hip joint.

Early and adequate treatment of congenital deformities of the hip joint and of lesions which may be followed by deformity and incongruity of the joint is emphasized in order to prevent the appearance of the more disabling stages of secondary degenerative arthritis.

In patients requiring surgical treatment, arthrodesis appears to be the most reliable method of effecting a good functional result, that is, freedom from pain and from recurrence of symptoms, further disability and deformity. Of 65 cases of degenerative arthritis of the hip joint without underlying aseptic necrosis, arthrodesis was carried out in 22, with a good functional result in 15. Other surgical procedures failed to give uniformly good results in 27 of 43 cases; there were 2 postoperative deaths. In 12 cases more than one operation was carried out. The results were poor in 7 cases and good in 5 cases, in which arthrodesis terminated in fusion.

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# PRESENT STATUS OF THE INJECTION TREATMENT OF HERNIA

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SINCE January 1936 I have been attempting to evaluate the injection method of the treatment of hernia. By that time, so many papers reporting favorable results with the method had been published that anyone interested in hernia was forced to look into the method or at least could no longer ignore it. I therefore started using the method in two hospital clinics and also used it in a few private patients. My early experiences with the method were published in March 1941.[1] Then the war came, with the disruption of civilian pursuits that war always entails, and since returning from the war I have tried to pick up some of the loose threads, take advantage of the passage of time and form an estimate of just where the method stands today.

Obviously in a paper on the present status of the injection treatment of hernia there is no place for a discussion of the history or rationale of the procedure, the indications and contraindications, the technic of injection, solutions used or complications. All these have been discussed many times and in many published articles and also in textbooks on the subject. During the decade roughly approximating the 1930's, many apparently unbiased articles appeared on the subject of the injection treatment of hernia, and considerable enthusiasm was developed for the procedure. Bratrud,[2] Rice,[3] Fowler,[4] Harris and

1. Koontz, A. R.: Experiences with the Injection Treatment of Hernia, South. M. J. **34**:297, 1941.

2. Bratrud, A. F.: The Ambulant Treatment of Hernia, Journal-Lancet **53**: 673, 1933; Minnesota Med. **16**:446, 1933; **18**:441, 1935; Ann. Surg. **105**:324, 1937; Wisconsin M. J. **36**:34, 1937; in Nelson Loose-Leaf Living Surgery, New York, Thos. Nelson & Sons, 1937; Hernia in Industry, S. Clin. North America **22**:1091. 1942.

3. (*a*) Rice, C. O.: The Injection Treatment of Hernia, Minnesota Med. **17**: 248, 1934; (*b*) The Rationale of the Injection Treatment of Hernia, ibid. **18**:623, 1935; (*c*) Hernia: Its Cure by the Injection of Irritating Solutions, J. Iowa M. Soc. **26**:279, 1936; (*d*) Complications Associated with Treatment of Hernia: Injection Versus Operative Treatment, Minnesota Med. **24**:206, 1941. (*e*) Rice, C. O., and Larson, L. M.: Technic for the Injection Treatment of Hernia, South. Surgeon **5**:227, 1936; (*f*) Complications and End-Results Associated with the Injection

*(Footnote continued on next page)*

White,[5] McKinney,[6] McMillan and Cunningham,[7] Manoil,[8] Crohn[9] and others reported excellent results with large series of cases and forced the method into a position in which it could no longer be condemned without a hearing. During the past six years the publications on the subject have diminished markedly in number. Undoubtedly, this is in large part due to the war. It is apparent also from personal communications from some of the former protagonists of the method that it is partly due to a waning of enthusiasm on the part of those who had published results during the preceding decade. In view of this it would seem that it is time to take stock and see whether the method should be continued in certain cases or entirely discarded.

First, I shall evaluate as nearly as possible the results obtained from the injection treatment of hernia. It is even harder to get

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Treatment for Hernia, ibid. **5**:390, 1936; (*g*) Fate of the Hernial Sac in Hernia Treated by the Injection Method, West. J. Surg. **44**:428, 1936. (*h*) Rice, C. O., and Mattson, H.: Histologic Changes in the Tissue of Man and Animals Following the Injection of Solutions Intended for the Cure of Hernia, Illinois M. J. **70**:271, 1936; (*i*) Injection Treatment of Hernia, Philadelphia, F. A. Davis Company, 1937.

4. Fowler, S. W.: Experience with the Injection Treatment of Hernia, M. Rec. **141**:207, 1935; Technic of Hernial Injection Treatment, ibid. **141**:387, 1935; Pioneers in Hernia Injection, ibid. **146**:481, 1937; Undescended Testicle Contraindicates Injection Treatment of Hernia, Clin. Med. & Surg. **44**:124, 1937.

5. Harris, F. I., and White, A. S.: (*a*) The Injection Treatment of Hernia, Surg., Gynec. & Obst. **63**:201, 1936; Injection Treatment of Hernia: Its Experimental Basis, California & West. Med. **45**:382, 1936; (*b*) Injection Treatment of Hernia: Its Present-Day Status, ibid. **45**:391, 1936; (*c*) Length of the Inguinal Ligament, J. A. M. A. **109**:1900 (Dec. 4) 1937; (*e*) The Truss in Relationship to Diagnosis and Injection Treatment of Inguinal Hernia, Am. J. Surg. **36**:443, 1937; (*f*) Injection Treatment of Hernia: A Critical Analysis of the Failures, Recurrences and Complications, ibid. **37**:263, 1937; (*g*) The Injection Treatment of Reducible Inguinal Hernia in Children, Arch. Pediat. **54**:665 (Nov.) 1937; (*h*) Evaluation of the Injection Treatment of Hernia: A Statistical and Analytical Study, J. A. M. A. **111**:2009 (Nov. 26) 1938.

6. McKinney, F. S.: An Evaluation of the Results of the Injection Treatment of Inguinal Hernia: A Review of the Employment of This Method at the University of Minnesota Hospital, Ann. Surg. **105**:338, 1937.

7. (*a*) McMillan, W. M., and Cunningham, D. R.: The Injection Treatment of Reducible Hernia, J. A. M. A. **106**:1791 (May 23) 1936. (*b*) McMillan, W. M.: The Injection Treatment of Hernia: An Evaluation Based on Five Years' Experience, Indust. Med. **8**:36, 1939.

8. Manoil, L.: Histologic Effects of Various Sclerosing Solutions Used in the Injection Treatment of Hernia, Arch. Surg. **36**:171 (Feb.) 1938; Evaluation of the Injection Treatment of Hernia in Older Patients: A Three Year Statistical Analysis, ibid. **41**:114 (July) 1940.

9. Crohn, N. N.: The Injection Treatment of Hernia, J. A. M. A. **108**:540 (Feb. 13) 1937.

reliable data on the number of recurrences following injection than on those following operation. The incidence of recurrences reported by various authorities varies from 100 per cent to 1 per cent. Undoubtedly a great many of the statistics published have been based on cases in which injection was entirely too recent. Obviously there is something wrong with the wide discrepancy. It is almost certain that those who reported the low percentage of recurrences had the facts somewhat colored by their optimism. On the other hand, the high percentage of recurrences reported by others makes one wonder whether the method was given adequate trial by them or whether it was used in properly selected cases. It is impossible to arrive at the truth from these figures.

Some authorities, Maier [10] and Imes,[11] go so far as to state that they do not believe that the injection method has any place in the treatment of hernia. Maier, in operating on patients who had previously received injections, found that the tissues showed notable fibrotic changes and had lost all their resiliency, which interfered considerably with normal healing. His recurrence rate was higher than in cases in which injection had not been previously given. My experience does not parallel that of Maier. It is true that a great deal of scar tissue is found at operation on patients who have received injections. This is also true in cases in which previous operations have been performed. I could detect no pronounced difference in the resiliency of the scar tissue. Scar tissue of any sort is notably nonresilient. Indeed, in operating for a recurrent hernia (previously operated on) not only does one encounter a large quantity of scar tissue but there is often also an appreciable distortion of the anatomy, which is not found in operations on hernias that have simply received injection treatment. I have no figures on the comparative recurrence rate, but it is well known that the recurrence rate after operation for recurrent hernia (previously operated on) is higher than that after primary operation, and one would expect the same to be true after operations on hernias previously treated by injection.

In 1940 the report [12] of the Council of Pharmacy and Chemistry of the American Medical Association stated that "the weight of evidence is preponderously in favor of acceptance of the injection

10. Maier, R. L.: The Present Status of the Injection Treatment of Hernia, Ann. Surg. **122**:85, 1945.

11. Imes, P. R.: Personal communication to the author.

12. Present Status of Injection Treatment of Hernia, report of the Council on Pharmacy and Chemistry of the American Medical Association, J. A. M. A. **115**: 533 (Aug. 17) 1940.

method of treatment of hernia in carefully selected cases" and further stated:

> The Council now concurs in the opinion that the method involves less danger of serious complications than surgery when employed only in selected cases of hernia by those skilled in the injection of suitable standardized solutions of known composition and action.

Since then there has been no report of the Council on the method.

It is the general consensus that better results are obtained with young persons than with old. Harris and White,[5g] who have had a large experience with the injection method in children, stated that the results have been uniformly good. Riddle [13] stated that he has never had a failure in a child.

Some of the strongest advocates of the method a decade ago have considerably modified their views with regard to it. Rice [5a] in 1941 stated that "the injection treatment of hernia should have a place in our surgical armamentarium." Recently [14] he has stated that he feels that the method has a definite, though limited, value and that he would consider using it only in young, thin persons. Harris [15] stated that it has a small but limited use in so-called potential hernias and in early complete inguinal hernias. Crohn [16] has abandoned the method and considers it of possible use only in small reducible indirect inguinal hernias.

On the contrary, Levy [17] wrote that "in reducible indirect hernia, completely controlled by a truss, with the external ring less than 3 cm. in diameter, recurrences were under 10 per cent." Aldrich [18] stated that he does not think that his recurrence rate with the injection method in selected cases runs as high as the average recurrence rate after surgical treatment.

Slobe [19] wrote that the injection method

> . . . can be used in many instances where surgery is contra-indicated as in the aged and infirm or in those who have serious constitutional ailments. Its use as a palliative measure with truss-wearing merits emphasis. The treatment of individuals with relaxed rings as potential hernias constitutes a field for the injection method which has many potentialities not yet adequately explored.

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13. Riddle, P.: Personal communication to the author.

14. Rice, C. O.: Personal communications to the author.

15. Harris, F. I.: Personal communication to the author.

16. Crohn, N. N.: Personal communication to the author.

17. Levy, L. H.: A New Hernia Injection Solution, with the Use of Vitamin C, M. Rec. **155**:65, 1942.

18. Aldrich, R. H.: Personal communication to the author

19. Slobe, F. W.: The Injection Treatment of Hernia, Indust. Med. **4**:226, 1935; **10**:145, 1941.

He also stated that "the present trend is reducing its use as a curative method but increasing its use as a palliative measure."

Archer[20] used the injection method as a cure in certain cases and to supplant a truss in others. He stated that he can keep most hernias cured if the patient will wear his truss in the daytime. In many cases in which a cure cannot be hoped for much can be done to alleviate the symptoms and to improve the general health.

McMillan[7b] in 1939 stressed the palliative value of the injection method and pointed out that when recurrences do occur a few more injections will usually take care of them while recurrences after surgical treatment require, for correction, operative procedures more extensive than those originally needed and there is less chance of a cure. In a recent communication (1946)[21] he stated that he is "now treating only very small hernias in young individuals or cases involving patients of advanced years who cannot tolerate surgery."

McKinney[6] in 1937 made the following statement (italics his):

> *Too much emphasis has been placed on the injection solution and not enough on a proper fitting truss.* The injection therapy has a place in the cure of hernia and instead of condemning it as quackery, surgeons should add it to their armamentarium in the treatment of hernia.

In a recent communication (1946)[22] McKinney reaffirmed, with only slight modification, the view expressed in his article in 1937. He now states that, contrary to his previous experience, he believes that direct hernias are easier to cure than indirect ones and require fewer injections. He goes on to say that he is of the opinion that "the injection treatment plus the truss has a place in the therapy of hernia, but the over-emphasis on the solution and particularly the extravagant claims of the manufacturers has brought disrepute to the method."

On returning last year from five years of military duty, I sent out follow-up letters to 179 patients who had been given injections during the five year period of 1936 to 1940 inclusive. Only 38 (21 per cent) of the patients returned for observation. Of the 38 patients, 25 (66 per cent) were cured. All these were five to nine year cures. The hernias were of all sorts, direct and indirect, large (some scrotal) and small, in stout and thin persons, a great many of which were in elderly clinic patients among whom no attempt at selection had been made. All comers were being taken at the time the injections were made. Nearly all the patients who were not cured were greatly improved. None of the cured patients was wearing a truss. The cured and improved patients were all extremely grateful and highly

20. Archer, E. W.: Hernia Injection, M. Press **213**:330, 1945.
21. McMillan, W. M.: Personal communication to the author.
22. McKinney, F. S.: Personal communication to the author.

satisfied with the treatment. One old man had had a scrotal hernia the size of an orange and had had his last injection eight years prior to the time of observation. He was completely cured and wore no truss, and I have never seen a more satisfied or appreciative patient. Cures of this type by the injection method, however, are unusual.

But what of the 141 patients (79 per cent) who did not return for observation? Undoubtedly a great many of these experienced unfavorable results and did not bother to return. One can only speculate on the number which came in this category. As most of the cases were observed in the clinic, probably a great many of the failures to return were due to indifference, irresponsibility or moving without leaving forwarding addresses. At any rate, an evaluation of this study gives no notion of the actual percentage of patients cured. It would seem fair to assume that there was a lower percentage of cures among those who did not return than among those who returned. Even if the percentage of cures among those who did not return was the same, it is even then still far below that for the operative method.

## COMMENT

What conclusions, then, are to be drawn from the data at hand? I do not see how an unbiased arbiter can decide otherwise than that the operative treatment is a far superior method than the injection treatment as a curative procedure. Is there any place, then, for the injection treatment? My answer is in the affirmative. The following are the types of cases in which this method has a place.

A great many old persons not fit subjects for operation because of infirmities of old age have large hernias which cannot be retained satisfactorily by a truss and which cause them distress and inconvenience. The hernias frequently come out and are difficult to reduce and strangulation is often imminent. Many of the patients can be symptomatically cured by the injection method and kept so if they continue to wear a light truss, while recurrences ensue in a great many of them if the truss is discarded. Most of these old persons experience immediate relief after the injection treatment is started. The hernia no longer tends to slide out under the truss, and they begin to lead comfortable lives and are grateful for the relief that has been given them. A good example of this type of case was a 93 year old patient (referred to me by Dr. Harvey Stone) who had a scrotal hernia on the right side the size of a grapefruit and a nonscrotal hernia on the left side the size of a tangerine. There had been threatened strangulation several times on the right side, and the patient had been admitted to the hospital for operation when I was asked to see him. Since nothing could be lost by the use of the

injection method, it was tried, and a cure (symptomatic at least) was effected on each side. The patient died a year later from a stroke, and two months before death a small recurrence had developed on the right side. He had refused to continue to wear a truss after the injections were completed, otherwise it was felt that he would have remained cured.

There are a certain number of persons in industrial plants who have enlarged rings but not actual hernias and who are refused employment because of this. (A great many such persons were rejected for the army for the same reason.) These men are usually entirely unaware that anything is wrong with them until they apply for employment. The chances are that a great many of them would go through life without the development of a hernia. The compensation laws have made employers wary of accepting them as employees. This is not a scientific attitude, but it is at least an understandable one. In these cases it is possible to close the ring tight, to obliterate any suggestion of impulse that may be present, and to make the men entirely acceptable for employment. These patients do not want operation because they do not feel that there is anything wrong with them. Besides, operation is not desirable, as in some cases the operation may convert a potential hernia into a recurrent one.

There are some persons who will not, on account of fear or for other reasons, submit to operation. Others feel that they cannot take the time off for an operation, for either financial or business reasons. Some of these can be cured and others improved by injection. Even if the ones who cannot be cured have to continue to wear a truss, they are almost without exception much more comfortable after injection than they were before. The disagreeable sagging down feeling on coughing has disappeared, and they are no longer conscious of the fact that they have a hernia except for the fact that they are wearing a truss, which causes them little discomfort. A great many patients who found a truss almost intolerable before injection are comfortable in wearing it afterward. Also a great many are enabled to wear much lighter trusses after injection than it was necessary for them to wear before.

It is possible also that the method may have a place in the treatment of small hernias which have been operated on several times and persistently recur through a defect in the fascia. In such cases there is probably a better chance of satisfactory treatment by this method than by further operation. One patient of mine had been operated on three times on each side and each time by an exceptionally competent surgeon. He came to me after the third time,

and the recurrence on each side was through a defect in the fascia above the external ring, which was only 1 cm. in diameter. Both of these were treated by injection, and the patient has now been well for nine years.

## CONCLUSIONS

1. The injection treatment of hernia has in no way replaced the operative method as the method of choice in treating hernia. Indeed, the extensive trial of the injection method during the past twenty years has placed the operative method in a firmer position than ever as the standard procedure in treating hernia.

2. A certain number of patients with hernia can be cured by the injection method. It is, however, at the present time impossible to determine just what percentage of cures can be obtained by it, even in properly selected cases.

3. The injection method has a place in the treatment of hernia, especially for patients coming in the following categories: (*a*) elderly persons unsuitable for operation due to the infirmities of old age; (*b*) persons rejected for industrial employment because of enlarged rings, with doubtfully demonstrable hernias; (*c*) patients who will not or cannot be operated on for personal reasons; (*d*) persons with certain types of recurrent hernia with small fascial defects.

4. It will be necessary for some of the patients in categories (*a*) and (*c*) to continue to wear trusses after the injection. This will depend on the size of the hernia and the build of the patient. Those who do have to continue to wear trusses are much more comfortable than they were before and can usually wear lighter trusses.

# TREATMENT OF PERFORATION OF GASTROJEJUNAL ULCER BY RESECTION OF STOMACH AND ANASTOMOSIS

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THE TYPE of primary operation performed for gastrojejunal ulcer and the technic are undoubtedly of great importance. As shown by the data recorded by Beresov,[1] Sokolov,[2] Levin [3] and Makkas,[4] the gastrojejunal ulcer most frequently complicates anterior anastomosis after the method of Wolfer, less frequently resection for exclusion as performed by Finsterer, the posterior anastomosis and resection of the stomach according to Billroth's type II and most rarely resection of the stomach according to Billroth's type I.

The degree of physiologic and morphologic alterations in the stomach playing a decisive role in the pathogenesis of gastrojejunal ulcer is dependent not only on the type of operation but also on the character of the primary disease and on the technical deficiency of the first operation.

The tendency of peptic ulcers toward perforation and penetration is well known. Nevertheless, despite the great number of gastroenteroanastomoses performed during recent years, perforation of gastrojejunal ulcers is relatively rarely observed. Makkas in 1931 succeeded in collecting 170 cases from the literature. Levin believed that the total number of reported cases outnumbers 200. Forty of these cases were reported by Russian surgeons.

The following types of operations for perforation of gastrojejunal ulcers may be accepted: (1) suturing; (2) suturing and degastroenteroanastomosis; (3) resection of a portion of the small intestine with the ulcer, and (4) resection of the stomach and anastomosis.

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1. Beresov, E. I., and Ribinskiy, A. D.: Bolesni operirowahnogo jeludka i ich lechenie, Gorky City, 1940.

2. Sokolov, S. E.: Beiträge zur Frage des Ulcus pepticum jejuni postoperativum auf Grund eines Materiels von 134 Fällen russischer Chirurgen, Arch. f. klin. Chir. **149**:230-273, 1928.

3. Levin, M. M.: Sabolewanija jeludka operirowannogo po povodu jaswi, Moskow, 1938.

4. Makkas, A. A.: Die freie Perforation des postoperativen peptischen Jejunalgeschwürs, Beitr. z. klin. Chir. **159**:61-84, 1934.

The statistical data of Makkas and of Toland and Thompson [5] show that resection of the stomach and anastomosis give the best results. It may be assumed that this impression does not reflect the real state of affairs, since not all fatal cases are reported.

Up to 1934, a total of 24 resections of the stomach and anastomosis was performed for perforation of gastrojejunal ulcer, with 2 deaths (Makkas). Levin has reported 1 case, in which a favorable result was obtained. Two cases in which favorable results were obtained have been reported by Cellarius.

One case occurred in this clinic, which is of interest from the standpoint of pathologic anatomy.

A man aged 62 was admitted to the hospital on Oct. 18, 1941. Since 1933 the syndrome of duodenal ulcer had been present. In 1939 he had undergone an operation in one of the clinics in Kiev. After the operation his condition had been relatively satisfactory. On Oct. 17, 1941 (two years after the operation and ten hours before his admission) he had sudden severe pain in the abdomen with persistent vomiting. The pulse rate was 90. There was superficial breathing. The abdomen was swollen, and diffuse severe pain prevailed in the upper left half. There was disappearance of hepatic dulness. Blumberg's sign was present over the whole abdomen.

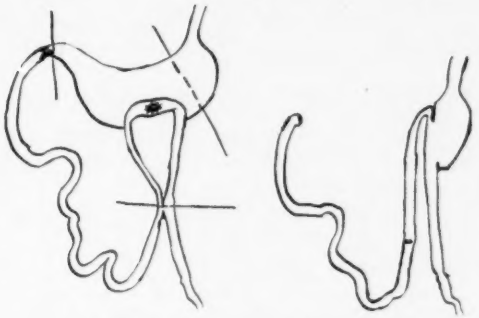
Laparotomy was performed for the syndrome of perforative peritonitis through a midline incision from the xiphoid process to the umbilicus. In the abdominal cavity there were gastroduodenal contents and turbid exudate. The incision of the abdominal wall was extended to the left from the upper angle, with transection of the sinew of the rectus abdominis. There was perforation of an area 4 mm. in diameter on the anterior wall of the small intestine in the region of the anastomosis. The borders of the perforated area were fragile. The jejunal loop entering into the area of the anastomosis was found lying opposite to the peristalsis of the stomach in the middle region of the latter. Between the afferent and efferent jejunal limbs a Braun enteroanastomosis was disclosed. The dilated stomach had hyertrophied walls. In the initial portion of the duodenum a dense ulcerous scar obturated the lumen and prevented permeability. The possibility of suturing the ulcer's opening was excluded because of the fragility of its borders and the inevitability of subsequent additional deformation of the anastomosis. Resection of the distal two thirds of the stomach along with the afferent and efferent jejunal limbs was carried out, the inferior wall of the interintestinal Braun anastomosis being preserved. The small intestine and the duodenal stump were sutured. In the performance of the anastomosis after the method of Finsterer, it was disclosed that the transverse colon had an extremely short mesocolon. This inherent small sagittal mesocolon hampering the formation of the opening for the anastomosis caused the surgeon to prefer anterior anastomosis for the first operation in 1939. A sufficiently large opening was made in the mesocolon and it was separated anteriorly without disturbing the blood supply of the colon and the operation completed precisely according to the Polya-Finsterer method.

For the first four days after operation the patient was in a poor condition. The pulse rate was 100 to 110, and he had frequent vomiting. Transfusion of

5. Toland, C. G., and Thompson, N. L.: Acute Perforation of Gastrojejunal Ulcer, Ann. Surg. **107**:827-852, 1936.

300 to 400 cc. of blood was carried out four times and lavage of the stomach three times. The wound healed with partial detachment of the ligatures. On Nov. 25, 1941, the patient was discharged in a satisfactory condition. Subsequent examination up to June 1942 showed recovery, increase in weight and good digestion. At the end of 1946 the patient, who had reached the age of 67, informed us that his condition had remained satisfactory.

Apparently the small size of the mesocolon and the resultant difficulty in exposure of the posterior gastric wall caused the surgeon to form the anterior anastomosis which was found far from the pylorus and deformed. The presence of the anterior anastomosis with the Braun enteroanastomosis created especially favorable conditions for the development and perforation of the gastrojejunal ulcer. If there had been no stenosing process in the initial portion of the duodenum, it would have been more rational to perform a degastroenteroanastomosis, with resection of only the deformed jejunal loop carrying the perforated gastro-



Resection of the stomach, with anastomosis.

jejunal ulcer, or to perform a degastroenteroanastomosis and suture the perforated area provided narrowing of the intestinal lumen could be avoided.

The whole pathologicoanatomic pattern called for an extension of the radical operation. It should be assumed that at the onset of peritonitis associated with perforation an extensive resection may be recommended only when no other operation can be performed successfully.

SUMMARY

In a patient aged 62 successful resection of the stomach and anastomosis were performed ten hours after perforation of a gastrojejunal ulcer. The development of the gastrojejunal ulcer was due to the fact that because of a short mesocolon an anterior gastroenteral anastomosis with Braun's enteroanastomosis had been performed for a duodenal ulcer two years previously.

# USE OF HUMAN FIBRIN FOAM AND THROMBIN SOLUTION AS HEMOSTATIC AGENTS IN GENERAL SURGERY

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HEMOSTASIS always presents a major problem to the surgeon. Where bleeding is brisk, as from a severed artery or large vein, it is usually stopped immediately by the application of forceps and ligatures. Much more difficult to control is the constant oozing that results from injury to small venules and capillaries. If one measures loss of blood by the increment of gain in dry sponges,[1] it becomes readily apparent that most of the loss of blood during the usual major surgical procedure is from the latter, rather than from the former, source of bleeding.

Bleeding from brain, kidney, liver or vascular tumors is difficult to control by the application of forceps or clips because of the friability of the tissues. In an operative field where infection is present or has subsided (as in decortication of a lung), the bleeding from the friable and tough fibrous tissue is most difficult to control, for hemostats and ligatures either tear out completely or cannot be applied.

Control of bleeding by packing with gauze in many instances has been a life-saving measure, but serious difficulties may be associated with the subsequent removal of the sponges. Often, the patient requires a general anesthesia as a means of combating the pain, and sometimes fatal hemorrhage follows the withdrawal of the packing.

Because of these problems, it is not surprising to note that surgeons turned to the use of clotting agents. In 1911, Cushing [2] used striated muscle as a hemostatic agent in neurosurgical procedures. He also suggested the possibility of obtaining fibrin from whipped blood and utilizing it instead of cotton gauze. This proposal resulted in the study by Grey,[3] in 1915, of sheep's fibrin, which he believed more useful than

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1. Wangensteen, O. H.: The Controlled Administration of Fluid to Surgical Patients, Minnesota Med. **25**:783-801, 1942.

2. Cushing, H.: Control of Bleeding in Operations for Brain Tumor, Ann. Surg. **54**:1-19, 1911.

3. Grey, E. G.: Fibrin as an Haemostatic in Cerebral Surgery, Surg., Gynec. & Obst. **21**:452-454, 1915.

cotton sponges as a hemostatic agent and found relatively nonirritating in animal tissues.

In 1938, Seegers and co-workers [4] were able to prepare a highly potent, purified, water-soluble thrombin obtained from beef plasma. They found this thrombin a valuable hemostatic agent in 225 cases.

Sponges made of a water-soluble gelatin base have been shown to be safe and effective hemostatic agents, both in the experimental animal and in man. The effectiveness of the sponge is apparently enhanced by the simultaneous use of thrombin solution. Microscopic studies of tissues in the rabbit into which portions of gelatin sponges had been inserted indicated that practically no foreign body reaction appeared about the inserted material, and the implants were completely absorbed in 30 dogs.[5]

Kenyon and associates [6] showed that the conversion of cellulose (surgical cotton gauze) to an organic acid by the action of nitrogen dioxide rendered that material soluble at the alkalinity present in the tissue juices and absorbable by the body. Soluble cellulose was first employed by Putnam [7] as a carrier for thrombin, but the recent observations of Seegers and Doub [8] that thrombin is inactivated by the acidity of the oxidized cellulose invalidate his results. The acidity can be neutralized with 1 per cent sodium bicarbonate, making the oxidized cellulose an effective carrier of thrombin.[9] However, the observations of Frantz and her co-workers indicated that oxidized cellulose is itself an effective hemostatic agent. They showed that it is readily absorbed and causes no appreciable foreign body reaction in the tissues, when used without thrombin solution.[10]

4. Seegers, W. H.; Smith, H. P.; Warner, E. D., and Brinkhous, K. M.: The Purification of Prothrombin, J. Biol. Chem. **123**:751-754, 1938.

5. Correll, J. T.; Prentice, H. R., and Wise, E. C.: Biological Investigation of a New Absorbable Sponge, Surg., Gynec. & Obst. **81**:585-589, 1945. Light, R. V., and Prentice, H. R.: Gelatin Sponge: Surgical Investigation of a New Matrix Used in Conjunction with Thrombin in Hemostasis, Arch. Surg. **51**:69-77 (Sept.) 1945.

6. Yockel, E. C., and Kenyon, W. O.: The Oxidation of Cellulose by Nitrogen Dioxide, J. Am. Chem. Soc. **64**:121-126, 1942. Unruh, C. C., and Kenyon, W. O.: Investigation of the Properties of Cellulose Oxidized by Nitrogen Dioxide, ibid. **64**:127-131, 1942.

7. Putnam, T. J.: The Use of Thrombin in Soluble Cellulose in Neurosurgery: Clinical Application, Ann. Surg. **118**:127-129, 1943.

8. Seegers, W. H., and Doub, L.: Oxidized Cellulose and Thrombin, Proc. Soc. Exper. Biol. & Med. **56**:72-73, 1944.

9. Uihlein, A.; Claggett, O. T., and Osterberg, A. E.: The Use of Oxidized Cellulose for Hemostasis in Surgical Procedures: Preliminary Report, Proc. Staff Meet., Mayo Clin. **20**:29-32, 1945.

10. Frantz, V. K.: Absorbable Cotton, Paper and Gauze (Oxidized Cellulose), Ann. Surg. **118**:116-126, 1943. Frantz, V. K.; Clarke, H. T., and Lattes, R.: Hemostasis with Absorbable Gauze, ibid. **120**:181-199, 1944. Frantz, V. K.: New Methods of Hemostasis, S. Clin. North America **25**:338-347, 1945.

Cohn and his co-workers,[11] in the department of physical chemistry at the Harvard Medical School, have in the course of large scale fractionation of human blood plasma made available purified portions of human fibrinogen and thrombin in large amounts.[12] From the fibrinogen, fibrin foam is made, and this with a solution of thrombin is used as an absorbable hemostatic agent.

Ingraham and Bailey[13] recorded their experience with the utilization of fibrin foam and thrombin solution both in the experimental animal and in a wide variety of general and neurosurgical procedures. From their experimental studies, it appears that fibrin foam causes only minimal acute inflammatory reaction and is gradually absorbed in one to four weeks with such minimal fibrous tissue replacement that the location of the foam could not be identified one month after implantation. Observations in over 400 clinical cases indicated that in man the response to fibrin foam is similar to that observed in the experimental animal (chiefly monkeys).

## MATERIAL AND METHODS

The fibrin foam and thrombin solution was supplied us by Drs. E. J. Cohn, O. T. Bailey and J. T. Edsall. The fibrin foam has a honeycombed structure, with nonuniform and varying degrees of porosity. It was forwarded in a sterile bottle, accompanied with a bottle of dry thrombin and a third bottle containing 30 cc. of sterile isotonic solution of sodium chloride, in a neat, compact package. When the agent is to be used, the saline solution is added to the dry thrombin; solution takes place readily. Pieces of fibrin foam, cut to the desired size, are soaked in the thrombin solution and are then ready for use in hemostasis. The fibrin foam, which is firm and somewhat brittle in the dry state, becomes rubbery and shrinks as fluid enters the air spaces. The fragments can be molded to conform to the shape of the surface and will retain the configuration after excess moisture has been removed.

11. Cohn, E. J.; Oncley, J. L.; Strong, L. E.; Hughes, W. L., and Armstrong, S. H., Jr.: Chemical, Clinical and Immunological Studies on the Products of Human Plasma Fractionation: I. The Characterization of the Protein Fractions of Human Plasma, J. Clin. Investigation **23**:412-432, 1944. Edsall, J. T.; Ferry, R. M., and Armstrong, S. H., Jr.: Chemical, Clinical and Immunological Studies on the Products of Human Plasma Fractionation: XV. The Proteins Concerned in the Blood Coagulation Mechanism, ibid. **23**:557-565, 1944.

12. Ingraham, F. D., and Bailey, O. T.: The Use of Products Prepared from Human Thrombin in Neurosurgery: Fibrin Foam as Hemostatic Agents, Fibrin Films in Repair of Dural Defects and in Prevention of Meningocerebral Adhesions, J. Neurosurg. **1**:23-29, 1944.

13. Ingraham and Bailey.[12] Bailey, O. T.; Ingraham, F. D.; Swenson, O.; Lowrey, J. T., and Bering, E. A., Jr.: Human Fibrin Foam with Thrombin as Hemostatic Agent in General Surgery, Surgery **18**:347-367, 1915.

If more fibrin is needed quickly, for some unforeseen emergency, it can be used after soaking in the thrombin solution for only one minute.

The value of fibrin foam is greatly enhanced by the fact that it can be left on the bleeding surface. As previously stated, the amount of tissue reaction after its use is minimal, and its absorption is rapid. Thus, the problems of pain and secondary hemorrhage that are associated with removal of cotton gauze packing are obviated.

## OBSERVATIONS

At this clinic, my associates and I have used fibrin foam and thrombin solution as a hemostatic agent in a variety of situations (table). They have been used most frequently in controlling the ooze in the gallbladder fossa following cholecystectomy . Bleeding in this situation is always difficult to control by the usual means of clamping

*Use of Fibrin Foam and Thrombin Solution as Effective Hemostatic Agents*

| Condition | Number of Cases |
|---|---|
| Cholecystectomy | 12 |
| Excision of metastases to liver | 2 |
| Traumatic laceration of liver | 3 |
| Resection of colon | 3 |
| Combined abdominoperineal resection of rectus | 4 |
| Carcinoma of stomach with extension to the pancreas | 1 |
| Pulmonary abscess | 1 |
| Sarcoma of posterior mediastinum | 1 |
| Subtotal thyroidectomy | 4 |
| Radical mastectomy | 6 |
| Curettage of actinomycotic infection of sinuses | 1 |
| Biopsy of sarcoma of the sacrum | 1 |
| Mediastinal adenoma of parathyroid | 1 |
| Epistaxis | 1 |
| Bleeding duodenal ulcer | 1 |
| Total | 42 |

and ligating because of the friability of the liver substance. Fibrin foam soaked in thrombin solution was successful in controlling troublesome oozing in 12 cases.

On 5 occasions fibrin foam was used as a valuable adjuvant to the usual means of controlling bleeding from the liver substance. In 2 instances a wide resection of the liver was done for removal of metastases. The brisk arterial and venous bleeding was controlled by clamping and ligature, but the residual oozing, which was considerable, was controlled by the application of fibrin foam. In the other 3 cases, the liver substance was injured accidentally in surgical procedures directed toward the gallbladder and common bile duct. In each of these cases, hemostasis was effectively obtained with the use of fibrin foam and thrombin solution.

In resections of the right or left half of the colon, as well as in combined abdominoperineal resections of the rectum, large retroperitoneal spaces are uncovered. From these areas the bleeding is usually

from ruptured venules and capillaries and is considerable. It is in such cases that we have found fibrin foam and thrombin a valuable hemostatic agent.

This means of hemostasis has been used in 2 instances of resection of the right half of the colon, in 1 instance of resection of the left half of the colon and in 4 instances of abdominoperineal resection of the rectum, with an excellent result in each case. In an additional case, in which a carcinoma of the stomach involved the tail of the pancreas, the retroperitoneal oozing which followed resection of this portion of the pancreas was adequately controlled by the application of fibrin foam and thrombin solution.

On 2 occasions, hemostasis was obtained effectively with fibrin foam and thrombin solution in surgical procedures on the chest. In the first case, that of a pulmonary abscess, many vascular adhesions between the chest wall and the visceral pleura of the lung had to be cut in order to mobilize the lung for pneumonectomy. The considerable oozing from the surface of the lung and the chest wall was controlled with fibrin foam and thrombin solution. In the second case, in an attempt to remove a sarcoma from the posterior mediastinum, a considerable amount of venous bleeding from the surfaces of the tumor was encountered. Clamping and ligature of bleeding points were not possible because of the friability of the tumor tissue. Hemostasis was effected by application of fibrin foam soaked in thrombin solution to the surfaces of the tumor.

Control of bleeding from the residual stumps of thyroid tissue left after partial thyroidectomy always presents a difficulty, for clamping in this region is fraught with the possibility of damage to the recurrent laryngeal nerve. On four occasions bleeding from the remaining thyroid tissue was effectively controlled by the application of fibrin foam and thrombin solution.

After radical mastectomy, large surfaces of the chest wall show considerable oozing. In 6 instances, fibrin foam and thrombin solution was used, with excellent hemostasis and noticeable reduction of postoperative drainage from beneath the dissected skin flaps.

Curettage of sinuses or biopsy of tumor tissue is often followed by considerable hemorrhage, which is difficult to control by the usual means. In this study, in a case of actinomycosis of the cecum with sinuses through the anterior abdominal wall, considerable bleeding from one of the sinuses followed curettage. This bleeding was controlled by packing the depth of the sinus with fibrin soaked with thrombin. In the other case of operative intervention in this group, considerable bleeding followed removal of a biopsy specimen from an ulcerating sarcoma over the sacrum. Here, again, it was not possible to clamp the bleeding point because of the friability of the tissues. Packing with sterile cotton

gauze was considered, but experience with a similar case had indicated that considerable bleeding might occur after removal of the pack. On this occasion, hemostasis was effectively obtained by packing the bleeding area with human fibrin foam and thrombin solution.

The rest of the cases in which human fibrin foam and thrombin solution was used will be described in greater detail, for as a group they presented problems in hemostasis of greater proportions than those already discussed. In each instance, the use of human fibrin foam and thrombin effected hemostasis in a most gratifying fashion.

CASE 1.—Mrs. J. D., a white woman aged 54, was admitted to the hospital with a diagnosis of adenoma of the parathyroid gland. On June 4, 1943, she was operated on, and a large adenoma of the parathyroid gland (6 by 7 cm., weighing 24 Gm.) was observed in the superior mediastinum. After its enucleation from beneath the manubrium sterni, considerable bleeding occurred. Because of the diffuse nature of the hemorrhage and its inaccessible position, an attempt at control by clamping and ligating bleeding points was out of the question. Hemostasis, however, was obtained by packing the area from which the adenoma had been removed with fibrin foam soaked in thrombin solution.

CASE 2.—A white man aged 64 was admitted with a diagnosis of hyertensive vascular disease. The patient had an attack of epistaxis of severe proportions, which was controlled only temporarily by nasal packing and cauterization of the bleeding point with silver nitrate. It was then treated by applying a small pledget of fibrim foam soaked in thrombin solution to the bleeding point in the nasal septum, which could be readily visualized. After this application, the bleeding stopped and did not recur for approximately one week. At this time, a second bout of epistaxis was controlled by the application of fibrim foam soaked in thrombin to the bleeding point. After this, the patient had no more bleeding.

CASE 3.—C. D., a white man aged 64, was admitted to the hospital bleeding from a duodenal ulcer. He was treated with repeated blood transfusions and gastric suction. Although his blood pressure and pulse were adequately maintained, the hemorrhage continued, as evidenced by the bloody gastric contents on aspiration. Four units of thrombin dissolved in 80 cc. of isotonic solution of sodium chloride was introduced through the nasal tube and the suction discontinued for two hours. After this treatment no more blood appeared in the aspirated gastric contents. After an adequate period of preoperative preparation, the patient was subsequently subjected to subtotal gastric resection, without event.

### COMMENT

From the work of Ingraham and Bailey,[12] human fibrin foam appears to cause only slight acute inflammatory reaction and is gradually absorbed, with minimal fibrous tissue replacement. The circumstance that in the cases just reviewed wound healing was uneventful and the postoperative clinical picture showed no evidences of unusual elevation of temperature or of the pulse or respiratory rate is confirmative of the observations of Ingraham and Bailey that the hemostatic agents used are well tolerated by the tissues.

In 1 of these cases, it was necessary to reexplore the common bile duct approximately two months after a cholecystectomy, in which

human fibrin foam and thrombin had been used to control bleeding from the gallbladder fossa. No discernible residual portion of the fibrin foam was seen. Although fibrous adhesions were present, they were no more numerous or extensive than those usually encountered on reexploring the area of the common bile duct after a previous cholecystectomy.

In the 1 case of bleeding duodenal ulcer previously described, bleeding ceased coincidentally with the administration of thrombin solution through the nasal tube. Subsequent operation revealed a chronic duodenal ulcer on the anterior wall. It is difficult to believe that the thrombin solution could have caused hemostasis if the bleeding had come from the gastroduodenal artery. Recently, however, I have observed several cases of erosive gastritis in which multiple minute, superficial ulcers are present and from which considerable bleeding may occur. It seems reasonable to expect that thrombin solution can act as a hemostatic agent more readily when the bleeding is from minute erosions than when it is from large vessels. How frequently erosive gastritis is the cause of bleeding, even in the presence of a known chronic duodenal or gastric ulcer, is not known . Thrombin is inactivated by acids; hence, one would not expect this agent to be effective in the presence of gastric juices. However, blood in the stomach may have sufficient buffering capacity to prevent the inactivation of the thrombin. Thus, it would seem that the use of human thrombin solution in the presence of bleeding from the stomach or duodenum is a worth while procedure.

## SUMMARY

Fibrin foam and thrombin solution has been used in 42 cases of varied types, with uniformly good hemostasis. It has been of particular value in controlling bleeding from the gallbladder fossa, liver substance and retroperitoneal tissue spaces.

From the clinical picture, in the cases in which it has been used, fibrin foam appears to be well tolerated by the tissues. Because the fibrin foam can be left within the tissue, it is a valuable hemostatic agent where packing is practically the only means of controlling hemorrhage, i. e., in bleeding following enucleation of a retrosternal tumor, removal of biopsy specimens of friable vascular tumors and curettage of sinuses with actinomycotic infection.

In a patient with a bleeding duodenal ulcer, the cessation of hemorrhage coincidental with the administration of human thrombin into the stomach through a nasal tube suggests that the hemostatic agent should be given further trial in cases of actively bleeding duodenal or gastric ulcer.

Use of fibrin foam and thrombin solution is a valuable addition to methods of hemostasis already available to the surgeon.

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# FOLLOW-UP RESULTS OF SURGICAL TREATMENT FOR NONUNION OF THE CARPAL SCAPHOID BONE

## Report of Nineteen Cases

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THE LITERATURE on fractures of the carpal bones of the wrist is voluminous. Confusion exists particularly in regard to treatment of nonunion of the carpal scaphoid. I have had experience in evaluating the results of acute injuries to the hand of soldiers in training and in combat and also in the evaluation of chronic wrist complaints of inductees. Many of the latter had been under the care of both civilian and military physicians and were treated for so-called sprain of the wrist.

A total of twenty operations has been performed on a series of 19 patients who had nonunion of the carpal scaphoid. The procedure used in 16 patients was originally described by Gordon Murray.[1] A bone graft taken from the tibia was employed. Successful bony union occurred in every instance but 1 (case 3, retroulnar dislocation of the capitate). In 8 of the 16 cases supplementary drilling was done during the bone-pegging procedure. Follow-up studies indicate that surgical treatment is attended by sufficient success to warrant the use of a bone graft procedure in well selected cases.

In order to evaluate the problem of nonunion, knowledge of the physiologic function of the carpal scaphoid bone and an understanding of its anatomic relationships are desirable.

### ETIOLOGIC FACTORS

Most injuries of the scaphoid are caused by indirect violence such as a fall on an outstretched hand. The bone acts as a buffer between the distal carpus and the radius. In most cases the force of the fall is indirectly transmitted to the capitate and then to the scaphoid through the third metacarpal bone. The severity of compression of the scaphoid depends on the degree of radial or ulnar deviation at the time of the impact.

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1. Murray, G.: Bone Graft for Non-Union of Carpal Scaphoid, Brit. J. Surg. **22**:63-68 (July) 1934; Surg., Gynec. & Obst. **60**:529-530 (Feb.) 1935.

### DIAGNOSIS

The history of a fall on the outstretched hand, tenderness on the ventral surface over the scaphoid or in the anatomic snuffbox and pain at these points on percussion of the extended thumb strongly suggest a lesion of the scaphoid bone. Roentgenograms taken at the proper angle may give conclusive evidence of fracture. Occasionally the central beam of the roentgen ray fails to coincide with the plane of the fracture. Satisfactory views may be taken with the fist clenched and the fingers resting on the x-ray plate with the palm down in extreme ulnar deviation and pronation. Soto-Hall [2] advocated the "praying position" of the hands for the lateral view. When the roentgenograms fail to show the fracture, one must rely on the clinical findings as presumptive evidence of fracture. Immobilization of the wrist for three weeks may be resorted to. After this, should roentgenologic studies again not reveal fracture the patient's ligamentous injury will have been helped by rest. At least two oblique views are needed to complete the study, with the palmar and dorsal surfaces of the wrist alternately next to the plate.

### DIFFERENTIAL DIAGNOSIS

Bipartite scaphoid is rare, but it may be confused with fracture; either of the two distal corners may be separate or cartilaginous, or there may be a separation at the waist. Developmentally, there are two centers of ossification instead of the usual one for each carpal bone. Bunnell [3] has indicated the following points in the differential diagnosis: the presence of the same abnormality in the other wrist, the absence of a history or of signs of injury and the rounded, clearcut edges with equal bone density of each part as shown in the roentgenogram. This differs from fracture because of the irregular margins and the patchiness or increased density of lime in the proximal fragment.

Thomas Dwight [4] stated that in bipartite scaphoids the line of division runs obliquely from near the outer end of the articular surface of the radius to about the middle of the concavity of the head of the capitate. When an unusual roentgenographic appearance of the carpal scaphoid is observed, one must consider developmental variations. Roentgenograms of the opposite wrist should be taken.

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2. Soto-Hall, R., and Haldeman, K. O.: Treatment of Fractures of Carpal Scaphoid, J. Bone & Joint Surg. **16**:822-828 (Oct.) 1934. Soto-Hall, and others: Fractures of the Carpal Scaphoid, J. A. M. A. **129**:335-338 (Sept. 29) 1945.

3. Bunnell, S.: Surgery of the Hand, Philadelphia, J. B. Lippincott Company, 1944.

4. Dwight, T.: Variations of the Bones of the Hands and Feet, Philadelphia, J. B. Lippincott Company, 1907.

### INCIDENCE

The fracture most commonly occurs in the male sex principally because of the fact that there is a greater participation in industry and in athletic events which expose to trauma. The right wrist seems to be involved a little more commonly than the left. The fact that most persons are right handed may be a contributing factor.

Thorndike [5] noted that in 11 (65 per cent) of a series of 17 cases involving college students there were old or previously unrecognized fractures. The incidence was about four times that of Colles' fractures in the age group between 16 and 25 years of age. Zwerg and Heideman [6] reported that 1.3 per cent of all fractures occur in the scaphoid. In the annual report from the Surgeon General of the United States Navy for the years 1933 to 1936 inclusive 2.2 per cent of the 6,544 fractures of all bones were said to be fractures of the scaphoid. In studying 100 such fractures, Burnett [7] found that only 6 per cent occurred in females. Forty-eight per cent of his patients were 20 years of age or under.

Böhler [8] mentioned that Schenk collected all the cases in their hospital over a six year period and found that there were 437 cases of carpal injuries. During the same time there were 669 cases of fractures and separation of the epiphysis of the lower end of the radius.

Cutler [9] estimated that failure of union occurs in 30 to 40 per cent of all cases of fractures of the carpal scaphoid. Compere and Banks [10] recognized aseptic necrosis of the carpal scaphoid to be second in frequency only to aseptic necrosis of the head of the femur. They stated that fractures through the waist of the carpal scaphoid result in necrosis of the proximal fragment in about one third of all cases.

### CLINICAL FINDINGS

In the fresh cases there is some localized swelling over the carpal region. This is always distal to a line drawn between the styloid processes. There is soft edema in the region of the anatomic snuffbox but no ecchymosis as is frequently seen in other fractures. Pressure in the snuffbox causes some discomfort. Motions in the wrist joint are limited and painful, especially those of dorsal flexion and radial flexion. Hand grip is usually impaired.

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5. Thorndike, A., Jr., and Garrey, W. E.: Fractures of the Carpal Scaphoid, New England J. Med. **222**:827-830 (May 16) 1940.

6. Zwerg and Heideman, cited by Hook.[18]

7. Burnett, J. H.: Fractures of the (Navicular) Carpal Scaphoid, Surg., Gynec. & Obst. **60**:529-530 (Feb.) 1935.

8. Böhler, L.: The Treatment of Fractures, ed. 4, Baltimore, William Wood & Company, 1935.

9. Cutler, C. W.: The Hand: Its Disabilities and Diseases, Philadelphia, W. B. Saunders Company, 1942.

10. Compere and Banks, cited by Waugh and Reuling.[23]

### PROGNOSIS

Any fracture untreated or improperly treated for as long as three weeks should be considered as a neglected fracture, and the chances of getting primary union by immobilization are not so good as one would expect to obtain with earlier immobilization.

Thorndike and Garrey [5] indicated that in their experience the disability in cases of nonunion is rather insignificant and often negligible. This is the case even for periods of up to five years after the fracture. They advised that only patients with definite disability should be urged to have the open operation of bone pegging or drilling. Cravener and McElroy [11] obtained good results in 14 of 15 carpal scaphoid fractures with the bone peg procedure. They stated that if one wanted to be absolutely certain of the result in the treatment of waist fractures, even those less than a week old, fragments should be joined by a bone graft. For ancient ununited fractures associated with a degenerative arthritis, these authors advocate removal of the proximal fragment. They are also of the opinion that in cases in which the degenerative type of arthritis has already set in no bone grafting or drilling will restore the wrist to normal.

Böhler [8] stated that he has never observed a case in which the usefulness of the hand has returned to normal after the removal of the carpal scaphoid. After the bone has been removed the hand inclines to the radial side and the hand grip is weakened.

Kemper [12] has collected over 60 instances of removal of the scaphoid and lunate bones. In all of them the function of the hand was poor.

Hirsch [13] reported excellent results in 9 cases after total removal, with perfect return of function of the wrist and with no trace of radial deviation of the hand.

### PATHOLOGIC PROCESS

Armstrong [14] has indicated that three factors may contribute to nonunion of the carpal scaphoid. In the first place, the structure of the bone is cancellous and there is no true periosteum. Hence new bone formation is slow. In the second place, the fracture impairs the blood supply to the fragments. A third factor may be inadequate treatment which allows movement to take place between the fractured surfaces.

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11. Cravener, E. K., and McElroy, D. G.: Fractures of the Carpal (Navicular) Scaphoid, Am. J. Surg. **44**:100-106 (April) 1939.

12. Kemper, cited by Böhler.[8]

13. Hirsch, M.: Konservative oder operative Therapie der Fraktur des Os navicular carpi? Wein. med. Wchnschr. **85**:803-804 (July 13, 1935): comment by Böhler: ibid. **85**:1085 (Sept. 28) 1935; reply by Hirsch: ibid. **85**:1086 (Sept. 28) 1935.

14. Armstrong, J. R.: Closed Technique for Fixation of Fractured Carpal Scaphoid, Lancet **1**:537-540 (April 26) 1941.

Hook [15] has shown that motion in the proximal row of the carpus requires more extensive cartilaginous surfaces for articulation with the radius than that in the distal row. This proportionately large joint or cartilaginous surface reduces the area for ligamentous and capsular attachment, thereby lessening the area in which the blood supply may reach the bone. This is especially true of the scaphoid, where the blood supply, which consists of small terminal twigs, enters the bone through the fibers of the collateral radial ligament. In the study of 297 carpal scaphoids removed from cadavers, Obletz and Halbstein [16] found that in 13 per cent there were no arterial foramens proximal to the constricted midportion or "waist" of the bone. In 20 per cent there was a single small arterial foramen at the waist or proximal to it, and in 67 per cent there were two or more foramens proximal to it. Since most scaphoid fractures occur through the waist of the bone, this finding may be of importance in the development of nonunion.

When the carpal scaphoid is injured, some crushing in the spongiosa, with damage to the blood supply, occurs. The nutrient vessels which enter through the periosteum, the nutrient foramens and the ligamentous attachments may be torn off. Absorption of bone takes place at the fracture line, and an intervening space may be visible roentgenologically. When immobilization is inadequate, the absorption process continues. A cystlike formation in the nonviable fragment sometimes occurs (fig. 5*A*). A slow aseptic necrosis develops over a period of many weeks. Since the blood supply is impaired, there is little or no attempt at repair. Scarring and irritation in the synovia and bones of the wrist occur, with resulting osteoarthritis deformans.

Fractures throughout the tubercle, which is vascular and extra-articular, unite whether splinted or not.

Occasionally there is cominution, with more or less displacement. The injury may be associated with dislocation of the semilunar bone (case 3). Complicating fractures of the radius and ulna may occur.

### PHYSIOLOGIC PROCESS

MacConaill [17] pointed out that the carpal scaphoid moves with the proximal carpal row in the earlier stage of dorsiflexion and with the distal row in the later stage. Conversely, the scaphoid moves with the distal row in the earlier stage of volar flexion and with the proximal row in the later stage. In the course of the movement from full volar flexion

15. Hook, F. R.: Fractures of the Carpus, U. S. Nav. M. Bull. **37**:553-566 (Oct.) 1939.

16. Obletz, B. E., and Halbstein, B. M.: Non-Union of Fractures of Carpal Navicular, J. Bone & Joint Surg., **20**:424-428 (July) 1928.

17. MacConaill, M. A.: Mechanical Anatomy of the Carpus and Its Bearing on Some Surgical Problems, J. Anat. **75**:166-175 (Jan.) 1941.

to full dorsal flexion movement of the capitate on the scaphoid occurs up to the position of extension; thereafter these bones are at rest on each other but move together on the lunate until full dorsiflexion has been attained. Conversely, in the movement from dorsiflexion to full volar flexion the capitate and scaphoid move on the lunate during extension of the hand; thereafter the capitate moves on the lunate and the scaphoid, which are, in turn, immobile. The dynamic relations of the scaphoid in various carpal positions provide the key to the mechanism of the severity and type of the injury. The side to side pressures of the bones against each other are just as important functionally as the longitudinal pressures.

## TREATMENT

Fractures of the carpal bones, particularly the scaphoid, treated within a few days of injury unite in a high percentage of cases if immobilization is effective. Roentgenologic evidence of union can be expected in from eight to twelve weeks. Bony or fibrous union may result nevertheless from immobilization alone, if it is maintained for periods ranging from four to eighteen months. In civilian life, such treatment may be compatible with a comparatively normal existence on the part of the patient, but in the services, under wartime conditions, immobilization of one wrist in plaster renders a man noneffective. Any form of treatment which may cut down the period of immobilization necessary to obtain bony union is worth while. The factors seem to indicate that the ideal method of treatment would be a combination of external and internal fixation, preferably by the use of an autogenous bone peg. The introduction of a bone peg across the bony fragments should hasten bony union.

Armstrong [14] stated that the technics of bone grafting are open to grave objections. This is particularly so when considerable stripping of the scaphoid, with consequent disturbance of its blood supply, is carried out. To overcome these disadvantages he has developed a closed operative technic whereby the peg can be introduced through a small incision in the skin under roentgenologic control, without any exposure or stripping of the fragments of the scaphoid.

Edelstein [18] advocated the proper positioning in a cast which holds the wrist in dorsiflexion and radial deviation. This position approximates the radial styloid and the lesser multangular against the outer fragment of the fracture and compresses the latter against the inner fragment, which is jammed up against the capitate.

Böhler [8] disapproved of the removal of the scaphoid for nonunion and quoted Kemper, who reported a series of 60 cases in which removal of the scaphoid resulted in poor function of the hand.

18. Edelstein, J. M.: Treatment of Ununited Fractures of the Carpal Navicular, J. Bone & Joint Surg. **21**:902-908 (Oct.) 1939.

A method of treatment which consists in filling both fragments and the space between them with fresh living cancellous bone taken from the greater trochanter has been described by Matti [19] (from Hook [15]). The fragments are hollowed out with a sharp curet, and the cavity is packed with cancellous bone. Satisfactory results in 3 patients treated in this manner were reported. Kellogg Speed [20] (from Hook [15]) expressed the belief that a fusion of the diseased fragments to the healthy neighboring carpus is preferable to excision. Hook found that proper treatment of recent fractures of the scaphoid results in a high percentage of cures (75 to 100 per cent).

Bunnell [3] favored excision in all cases of sequestration of the proximal fragment of the scaphoid in order to prevent osteoarthritis. The sharp edges of the distal fragment are rounded off where they articulate with the radius.

### OPERATIONS

Meekison [21] recognized the following procedures:

1. Immobilization from four to six months if necessary, depending on roentgenographic evidence of union. This treatment is reserved for fractures which are not too old, that is, of one to three months' duration, and in which accurate reduction can be obtained.

2. Excision. This applies to the proximal fragment, when it is the smaller of the two and shows evidence of aseptic necrosis. Excision is not advocated in cases of waist fractures. It is undertaken before arthritic changes take place in the wrist joint.

3. Bone graft. The simple dorsal approach using a peg or inlay graft is the safest.

4. Arthodesis of the wrist. This procedure offers freedom from pain and a strong wrist. However, dorsiflexion and volar flexion are lost but supination and pronation are preserved.

Milgram [22] (cited by Meekison [21]) described a method of denuding the dorsal aspect of both fragments, by which they are hollowed, particularly the proximal one, and the continuous cavities so created filled with concellous bone. This bone is obtained beneath the crest of the ilium. This procedure has been used in 10 cases, in 9 of which union has occurred with a bony bridge across the gap. In 1 aseptic necrosis of the proximal fragment has persisted. Milgram pointed out the fact that all fractures of the carpal scaphoid bone do not merit intervention. He has seen asymptomatic nonunion of the carpal scaphoid persist with-

19. Matti, cited by Hook.[15]

20. Speed, cited by Hook.[15]

21. Meekison, D. M.: Some Remarks on Three Common Fractures of the Carpal Scaphoid, J. Bone & Joint Surg. **27**:80-85 (Jan.) 1945.

22. Milgram, cited by Meekison.[21]

*Results of Treatment for Nonunion of the Carpal Scaphoid Bone*

| Case | Age | Conservative Treatment | Time Interval Between Fracture and Operation | Time of Letter Follow-Up Since Operation | Pain | Latest Clinical Picture | | Hand Grip | Rating of Result * | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Flexion Limited | Extension Limited | | | |
| 1 | 19 | Early strapping, late splinting | 14 mo. | 27 mo. | Slight, occasionally on lifting | No | No | Good | Excellent | Boxing injury—waist fracture |
| 2 | 32 | Early strapping | 4 mo. | 5 yr. | Occasionally in wet weather | 10% | 10% | Good | Excellent | Fall—left waist; distal fragment white; patient given medical discharge because of diabetes; salesman |
| 3 | 21 | Immediate cast, but retroulnar dislocation of capitate was unreduced for 2 wk. | 1st operation 2 weeks; reduction, drilling and curettage of fragments; 2nd operation 4 months; bone pegging | 2 yr. | Frequent | 35% | 35% | Poor | Poor; nonunion 3 years later | Diving accident—left waist; proximal fragment white; arthritis in radiocarpal joint |
| 4 | 22 | Late cast, worn 9 wk. | 6 mo.; fragments drilled and curetted | 5 5/12 yr. | On lifting | 25% | 35% | Fair | Fair | Fall—left waist; distal fragment white; arthritis; bartender |
| 5 | 28 | No treatment | 4 mo. | 6 mo. | Occasionally | 10% | 10% | Good | Good | Fall—right waist; proximal fragment white; overseas service |
| 6 | 23 | No treatment | 10 mo. | 4 8/12 yr. | Occasionally | 15% | 15% | Good | Good | Fall—right waist; distal fragment white; overseas service |
| 7 | 33 | Late strapping | 5 yr. | 2 9/12 yr. | Slight | 10% | 10% | Excellent | Excellent | Jerk injury—right proximal ⅓ of bone; roentgenogram in 1943 showed solid union |
| 8 | 22 | No treatment | 1 yr.; fragments drilled and pegged | 1 yr. | No | 10% | 10% | Good | Excellent | Fall—left waist |
| 9 | 29 | Cast 11 wk., late | 10 mo. | 4 yr. | Slight, occasional | No | No | Excellent | Excellent | Lifting—left waist; proximal fragment white; prize fighter |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 29 (Negro) | ..... | 3 yr.; fragments curetted and drilled | 1 yr. | No | No | No | Excellent | Excellent | Fall—right waist; proximal fragment white |
| 11 | 22 | Early cast | 4 mo. | 4 yr. | No | No | No | Excellent | Excellent | Fall—left waist; complicated by acute hemorrhagic pancreatitis; postal clerk |
| 12 | 30 | No early treatment; roentgenogram in 1933 showed fracture; subsequent casts on 5 occasions | 9 yr.; fragments drilled and pegged; rough surfaces | 1 yr. | No | 15% | 15% | Excellent | Excellent | Fall—right waist |
| 13 | 24 | Early strapping 1937 | 5 yr.; drilling and bone pegging | 4 yr. | Slight | 15% | 15% | Excellent | Excellent | Fall—left waist; distal fragments white |
| 14 | 22 | Late casts | 6 mo. | 3½ yr. | No | 20% | 20% | Good | Good | Fall—right waist; proximal fragment white |
| 15 | 25 | Late casts 6 months | 3 mo. | 9 mo. | No | 15% | 15% | Excellent | Excellent | Fall—right waist |
| 16 | 27 | ..... | 8 mo. | 1 yr. | Occasional, on lifting | No | No | Good | Good | Fall—waist |
| | | | Partial Scapholdectomy (3 Case Reports) | | | | | | | |
| 17 | 29 | 1934—no cast treatment | 8 yr.; fragile white proximal fragment removed; poorly approximated | 4 yr. | Yes | 20% | 30% | Fair | Fair | Boxing—left waist; arthritis; proximal fragment white; overseas service |
| 18 | 20 | No treatment | 3 mo.; fragments separated and eburnated; looked antique; distal fragment removed | 1½ yr. | Slight | 15% | 20% | Good | Good | Fall—right waist; distal fragment white; overseas service |
| 19 | 26 | Late splinting | 2 mo.; retroulnar dislocation of capitate reduced 2 mo. later; proximal scaphoid and lunate removed; arthrodesis to be done later | 1 mo. | Yes | Wrist and finger limitation | 50% | Poor | Poor | Fall—right waist, complicated by a median palsy (distal) and limited finger motion |



* End results listed in the table were based on the following criteria: excellent—not more than 15 degrees of limitation of palmar flexion or dorsiflexion, pain only in wet weather and good hand grip; good—pain in wet weather or on prolonged use of the wrist when working; hand grip good and motion limited by not more than 25 degrees in either palmar flexion or dorsiflexion; fair—pain on moderate exertion, limitation of motion marked and hand grip poor; poor—pain on slightest exertion, considerable limitation of motion, weak hand grip and roentgenologic evidence that the bone is not healed or evidence of arthritis.

An additional patient has been treated since this table was prepared. The bone graft consisted of the cortex taken from the ulna. There was sound bony union of the waist fracture. The end result is excellent after one year.

out arthritis, and in another case of nonunion he has observed apparent union occur years later spontaneously.

Waugh and Reuling [23] have added another method of treatment, which consists of replacement of the scaphoid which has been excised by means of vitallium® prosthesis.[23a] This operation is indicated in (1) fresh fractures with the fragments badly comminuted and displaced, particularly those involving the proximal portion, (2) old cases of pseudarthrosis in which the site of fracture is through either the waist or the proximal portion and associated with local deforming arthritis and (3) cases of reinjury in which the clinical symptoms and the disability persist after an adequate period of immobilization.

## STUDY OF CASES

In every instance but one the fracture of the scaphoid was through the waist. In this case the fracture line was at the junction of the proximal and distal thirds of the scaphoid. All the patients operated on were between the ages of 20 and 31. The longest history of known fracture of the scaphoid, verified originally by roentgenologic study, was approximately eight years. During this interval the patient wore a cast on six occasions for varying periods, but nonunion resulted. After the bone peg operation, complete union occurred and the end result was excellent. In no instance in this series was operation performed for an acute fracture. Immobilization was used for at least four months, at the end of which time a bone graft procedure was performed if nonunion persisted. In 4 of the 16 cases there had been existing disability for at least three years prior to operation. The left wrist was involved in 9 cases and the right in 7 cases. After operation the average duration of immobilization in a cast was sixteen weeks. In each instance a tibial bone graft was removed from the anterior crest of the upper part of the tibia. Splinting of the leg for three weeks was accomplished with a posterior plaster splint. The patient was allowed up on crutches, and gradual weight bearing was instituted. When the tibia on the contralateral side is used as the graft donor site, walking with crutches is facilitated. The only postoperative complication in this series occurred in case 11, in which a postoperative acute recurrent pancreatitis developed which necessitated an exploratory laparotomy. Five of the 16 patients have a complete range of motion, and in follow-up letters they state that the hand which was operated on is just as good as the other one. Eight patients have slight pain which is noticeable when it is necessary to exert the wrist a great deal, as in lifting.

23. Waugh, R. L., and Reuling, L.: Ununited Fractures of the Carpal Scaphoid, Am. J. Surg. **67**:184-200 (Feb.) 1945.

23a. Vitallium contains cobalt, chromium and molybdenum.

Only 1 of the 16 patients was separated from the service, and this was for diabetes mellitus (case 2). This disease had no effects on bone union, and the end result was excellent.

Case 3 was one of traumatic fracture of the waist of the scaphoid and retroulnar dislocation of the capitate of two weeks' duration. A closed reduction was attempted using Kirchner wire fixation in the metacarpals and a Roger-Anderson dual half pin unit through the olecranon. Gradual traction on the anatomic splint applied under fluoroscopic guidance was unsuccessful (fig. 2). One week later an open reduction was performed, at which time the fracture dislocation was adequately reduced. The triquetrum was removed, and the surfaces of the scaphoid fragments were curetted. Kirschner wire drills were

Fig. 1 (case 1).—Preoperative (*A*) and nine month postoperative (*B*) roentgenograms indicating bony union. End result excellent.

inserted across the fracture line several times. Roentgenograms taken four months later revealed nonunion of the scaphoid. Open reduction was again performed. The proximal fragment appeared to be whiter than the distal one. A tibial peg graft was placed across the fracture line, and once again the fragments were drilled. The cast remained in place approximately four months postoperatively. Roentgenologic studies three years later indicated that scaphoid union had not occurred. The total period of immobilization from the time of injury was about nine months. The end result is rated as poor in this case since the patient continued to have pain, tenderness, limitation of motion, weak hand grip and inability to use the hand in the work required of him. These symptoms were due to fibrosis, arthritis and nonunion. This case was the only one in the series in which bony union was not obtained.

Fig. 2 (case 3).—*A*, retroulnar dislocation of the capitate and fracture of the scaphoid bone, lateral view. *B*, anteroposterior view showing fracture dislocation. *C*, immediate postoperative roentgenograms taken on March 12, 1941. The original open reduction was performed three months earlier, at which time the fragment were drilled. Nonunion occurred, and subsequent arthritic changes developed. The result was poor.

Conservative early treatment was successful in another soldier who sustained a retroradial dislocation of the capitate and concomitant fracture of the waist of the scaphoid (fig. 3 *A* and *B*). A closed reduction was successfully carried out on the day of injury under general anesthesia. Union of the fracture has occurred. A follow-up letter written several months later stated that the patient had a good range of motion and the only complaint was slight weakness of the hand grip and pain in wet weather. Two instances were observed in which necrosis developed in the scaphoid. In 1 case the distal (case 18) and in the other the proximal fragment (case 17) was involved. Both of the patients have continued to have disability despite excision of the affected fragment.

## OPERATION

With the hand held in full adduction and pronation, incision is made over the "snuffbox" just lateral to the extensor pollicis longus tendon

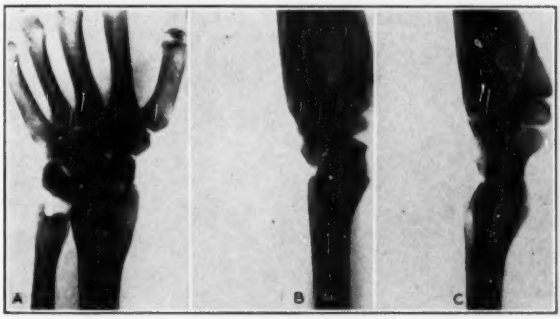


Fig. 3.—*A* and *B*, retroradial dislocation of the capitate and fracture of the carpal scaphoid. Treated early by closed method. Excellent result, clinically and roentgenologically. *C*, postoperative reduction.

down to the deep fascia. The superficial branches of the radial nerve and the abductor and extensor thumb tendons are identified and suitably retracted. The short extensor, the long abductor of the thumb and the extensor indicis proprius are retracted to the radial side and the long extensors to the ulnar side of the incision. It has been found convenient to use two small self-retaining mastoid retractors, one at each pole of the wound. The dorsal carpal ligament is incised, and a transverse incision is then made in the capsule which can be seen in the depth of the wound. Periosteal elevation is then accomplished over the lower end of the radius for a distance of about 1 cm. This allows a more satisfactory exposure of the joint, and subsequent closure is also facilitated. A minimum of dissection is essential over the scaphoid proper. Identification of the fracture is facilitated by having an assistant place

traction on the thumb, which draws the surfaces of the wrist joints apart. A "spud" is then inserted between the articular surface of the radius and the scaphoid. This allows excellent visualization of the

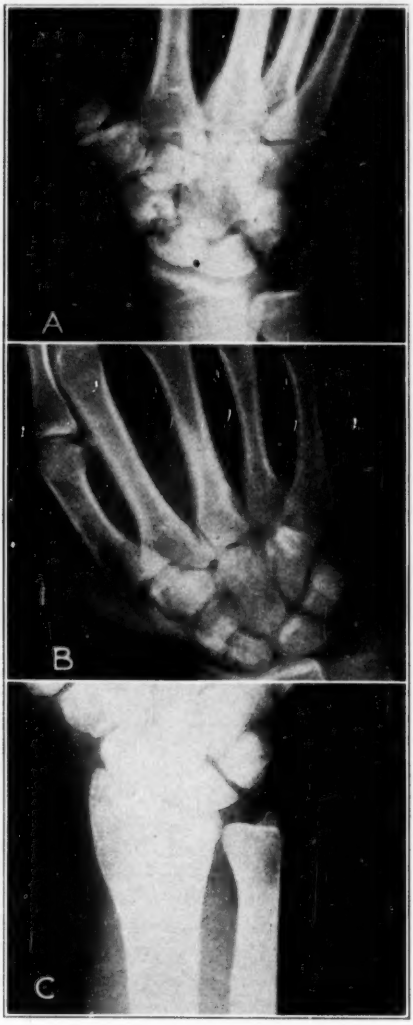


Fig. 4 (case 6).—*A*, preoperative roentgenogram taken in September 1941. *B*, operation in December 1941. The graft is in place. The excess bone is trimmed flush with the scaphoid. *C*, postoperative roentgenogram dated Oct. 11, 1942, indicating union. The end result was good.

fracture site. A small rongeur is used to make a drill starting point at the tubercle of the scaphoid. A 5/64 inch (0.19 cm.) drill is placed through the tubercle and across the fracture line down to a suitable

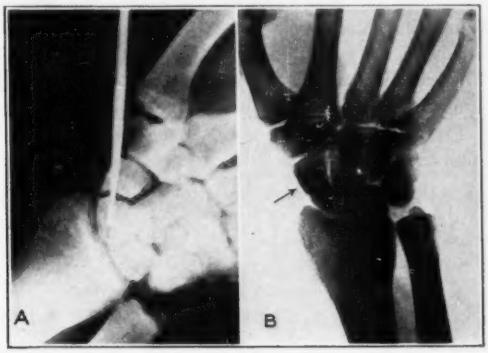


Fig. 5 (case 10).—*A*, operative roentgenogram on Jan. 27, 1942. The fragments were unstable. Curettage was accomplished. Impaction of the fragments is essential. *B*, roentgenogram taken ten months postoperatively indicates union. The end result was excellent.

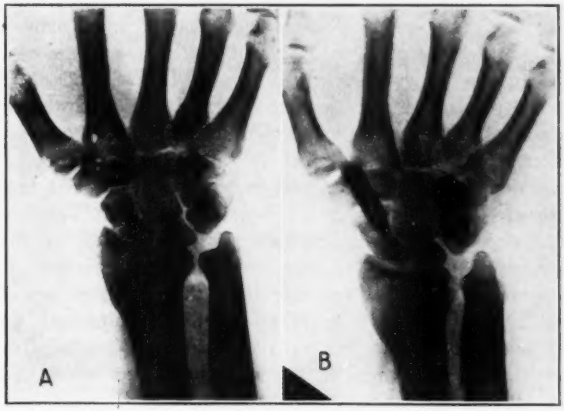


Fig. 6 (case 16).—*A*, preoperative roentgenogram dated August 1942. *B*, operative roentgenogram dated September 1942. Roentgenograms taken in July 1943 showed partial union only. Hand grip was strong, and the patient stated that the "hand is almost as strong as the normal hand." Roentgenograms in early 1945 showed that the bone peg was apparently completely absorbed. There was an excellent union of the fragments. The end result was good.

depth, which can be measured by means of a metal probe. The pneumatic tourniquet is then released, and hemostasis is accomplished. While roentgenograms are being taken, the team prepares a bone graft.

which is best obtained by an electric saw. The graft is suitably fashioned to a slightly greater diameter than the drill point which was used to make the hole in the scaphoid. The peg itself is usually not more than 2 cm. long, although the entire length of the bone may measure 4 cm. This length expedites the tapping of the peg across the fracture line. If the roentgenograms reveal satisfactory position and depth of the drill hole, the graft is then hammered into place, care being taken to impact the fragments. This is readily accomplished by means of a "spud" which holds the proximal end of the scaphoid while the distal end of the peg is tapped on. Another check roentgenogram is taken at this time to make sure that the graft is well across the fracture line. Excess bone is removed from the peg with a cutting forceps. The wound is closed in layers with fine cotton or silk. A plaster cast is applied from the olecranon to the metacarpal-phalangeal joints. It is cut out in such a way as to allow full motion of the finger joints. The thumb is placed in a position of slight abduction and moderate extension. The cast incorporates the thumb down to the interphalangeal joints but allows motion of the distal joint. If the wrist is placed in too much "cock up," undesirable motion of the wrist occurs.

## COMMENT

Three additional cases of nonunion of the carpal scaphoid are included in which the proximal fragment in 2 instances and the distal fragment in another was removed (cases 17, 18 and 19). The patients had pain in the wrist and limitation of motion postoperatively. Arthrodesis of the wrist is preferable to excision of one or more carpal bones, which was performed in case 19. This procedure was purposely done rather than a fusion because of marked limitation of motion in the finger joints. The case was one of unrecognized retroulnar dislocation of the capitate and fracture of the scaphoid of two months' duration. It was complicated by paralysis of the median nerve secondary to pressure from the dislocated lunate. At operation it was necessary to remove both the proximal scaphoid fragment and the lunate because the dislocation tended to recur. A radial deviation deformity of the wrist may occur unless a fusion procedure such as the Colonna [24] type is performed.

## SUMMARY

A review of the literature is presented, including a description of the anatomic, physiologic and pathologic changes resulting from injuries to the carpal scaphoid.

24. Colonna, P.: A Method for Fusion of the Wrist, South. M. J. **37**:195-199 (April) 1944.

An analysis has been made of 16 cases of fracture in which nonunion of the carpal scaphoid was treated by bone grafting. This includes a study of the end results in periods varying from one to five years.

Healing of the bone occurred in all but 1 of 16 cases in this series. In 6 of these combined operations of preliminary drilling and grafting were performed. The waist of the bone was involved in all but 1 of the cases. In the latter the proximal one third was the site of fracture. In 3 of the cases curettage of the surfaces of the fracture fragments was done. This procedure does not seem to be necessary. A study of the excellent results in this series indicates that in the more chronic cases in which there is no roentgenologic evidence of arthritis good function may be expected, particularly if good wrist motion existed prior to operation. The chief indication for operation was pain. A good prognosis can be expected in properly selected cases in which a bone peg is used. Only patients with definite disability should be urged to have the open operation of bone pegging.

For ancient fractures associated with a degenerative arthritis, wrist fusion should be strongly considered. If manual labor is not required of the patient, excision of the proximal fragment may be the procedure of choice. Arthrodesis can be done later if necessary. The proximal carpal row may be advantageously excised in some of these cases, and more particularly in instances of retroulnar dislocation of the capitate and fracture of the scaphoid bone.

# REACTION IN SURGICAL WOUNDS TO SURGICAL GUT, SILK AND COTTON SUTURES

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ST. LOUIS

PROVIDING that a suture material can be rendered sterile without significantly altering its physical state and providing that it endows a wound with sufficient mechanical tensile strength for coaptation over a period well beyond the usual time of appearance of biologic tensile strength, it may be considered for clinical usage. The nonabsorbable materials commonly employed fulfil these requirements, but it has been the experience of many that the commonly used absorbable material, surgical gut, does so only partially.[1]

The ultimate criterion, however, in evaluation of a suture material is the degree of foreign body inflammatory response that it incites in living tissue. Of obvious advantage is the use of a suture material found least detrimental to wound healing.

Considerable clinical and experimental data are existent indicating the greater degree of inflammatory response, with consequent higher incidence of wound complications including infection, with the use of absorbable materials.[2] There has also been presented some data indicating differences in the degrees of reaction incited by the various nonabsorbable materials, some finding cotton to be most innocuous.[3]

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Aided in part by the David May-Florence G. May Fund.

From the Department of Surgery, St. Louis Jewish Hospital.

1. (*a*) Howes, E. L.: The Strength of Wounds Sutured with Catgut and Silk, Surg., Gynec. & Obst. **57**:309 (Sept.) 1933. (*b*) Meade, W. H., and Ochsner, A.: The Relative Value of Catgut, Silk, Linen and Cotton as Suture Materials, Surgery **7**:485 (April) 1940. (*c*) Meleney F. L.: Infection in Clean Operative Wounds: A Nine Year Study, Surg., Gynec. & Obst. **60**:264 (Feb.) 1935; (*d*) The Problem of Catgut Sterility, Internat. Abstr. Surg. **71**:422 (Nov.) 1940.

2. (*a*) Halstead, W. S.: The Employment of Fine Silk in Preference to Catgut and the Advantages of Transfixing Tissues and Vessels in Controlling Hemorrhage, J. A. M. A. **60**:1119 (April 12) 1913. (*b*) Localio, S. A.; Casale, W., and Hinton, J. W.: Wound Healing: Experimental and Statistical Study; IV. Results, Surg., Gynec. & Obst. **77**:376 (Oct.) 1943; (*c*) V. Bacteriology and Pathology in Relation to Suture Material, ibid. **77**:481 (Nov.) 1943. (*d*) Whipple, A. O.: Use of Silk in the Repair of Clean Wounds, Ann. Surg. **98**:662 (Oct.) 1933. Howes.[1a] Meade and Ochsner.[1b]

3. (*a*) Meade, W. H., and Long, C. H.: The Use of Cotton as a Suture Material, J. A. M. A. **117**:2140 (Dec. 20) 1941. (*b*) Meade, W. H., and Ochsner, A.: Spool Cotton as a Suture Material, ibid. **113**:2230 (Dec. 16) 1939; footnote 1*b*.

There has been no single quantitative test of tissue reaction to suture materials. Histologic evidence of the cellular response is only qualitative. Statistical assays of specific wound complications with the use of various materials offer only indirect evidence of tissue reaction. I have therefore attempted to devise a method whereby the total tissue reaction to suture materials can be quantitatively determined,

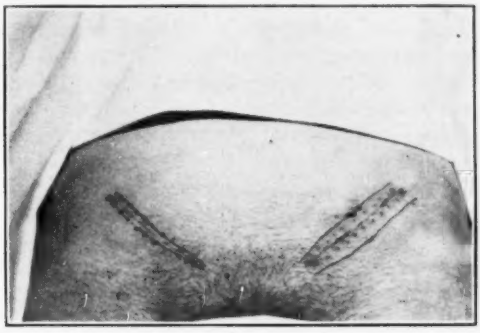

Fig. 1.—Width of subcutaneous induration marked on skin in case of bilateral herniorrhaphy six days postoperatively. Cotton used on right side, chromic surgical gut on left.

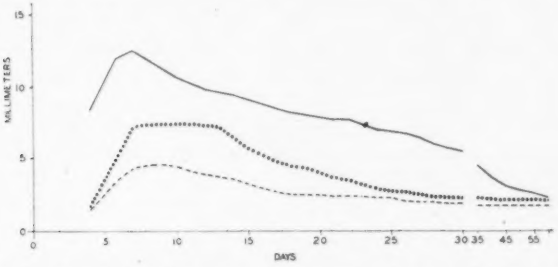


Fig. 2.—Mean induration curves of each group of cases. Cotton, broken line; silk, dotted line; surgical gut, solid line.

and, using the method, have compared the reactions to surgical gut, cotton and silk.

## OBSERVATIONS

*Method.*—The postoperative subcutaneous induration was measured in 30 patients, 10 each for the use of surgical gut, cotton and silk. The patients chosen for these observations were of the same age group and physical status. The same incision, body area, operation (inguinal herniorrhaphy) and surgical technic were employed in all cases, and all operations were done by the same surgeon. In all cases the material under study was used throughout except that nonabsorbable sutures were used for skin closure in all. All sutures were interrupted and of a size only sufficient to coapt tissues. Ordinary untreated cotton and black twisted untreated surgical silk of equal caliber by micrometric measurement were used.

Beginning on the second or third postoperative days, and thereafter every two to three days, the edges of induration were delineated by palpation and marked on the skin and the width of induration measured (fig. 1). The margin of induration was distinct to the palpating finger in all instances.

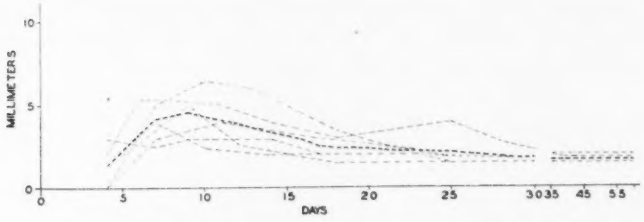


Fig. 3.—Mean induration curve of cotton (heavy line) with sample cases (light lines) to show greatest variability.

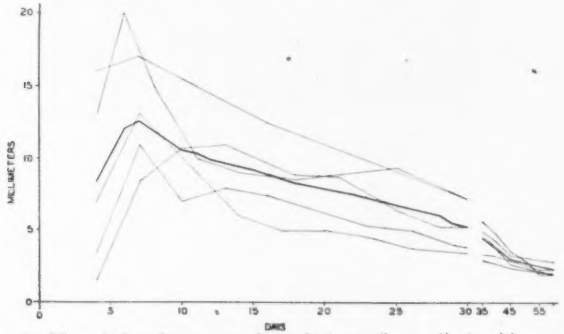


Fig. 4.—Mean induration curve of surgical gut (heavy line) with sample cases (light lines) to show greatest variability.

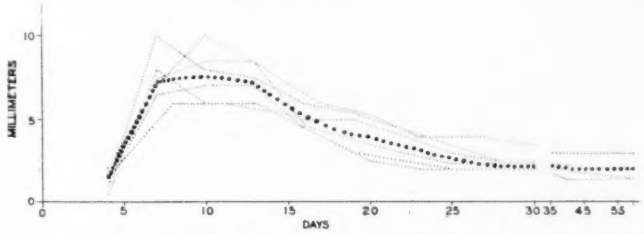


Fig. 5.—Mean induration curve of silk (heavy line) with sample cases (light lines) to show greatest variability.

*Results.*—Subcutaneous induration was found to appear in all wounds on the third to the fourth postoperative day. After its appearance the degree of induration increased rapidly and usually reached a peak on the sixth to the seventh postoperative day in all wounds and with all materials (fig. 2).

The induration incited by chromic surgical gut was found to be greater than that incited by the nonabsorbable materials and the variations from case to case greater (fig. 4, as compared with figs. 3 and 5). The induration with the use of silk was significantly greater than that with the use of cotton (fig. 2). At the end of two months there was but little difference in the induration of wounds sutured with the various materials (fig. 2).

In addition to careful control in selection of patients and in standardization of surgical technic, certain facts were forthcoming which indicated that the observed differences were not attributable to biologic variation alone. The induration curve of each person approximated the mean curve of the material used. The mean value was statistically significant (figs. 3, 4, 5). In bilateral operations using different materials on each side the same differences in induration were observed (fig. 1).

## COMMENT

Our observations have been based on the premise that subcutaneous induration adjacent to a postoperative incisional wound largely represents the inflammatory response of the tissue to exudation, necrosis and foreign body. That exudation per se is not a significant component of the palpable induration is evidenced by the fact that induration does not appear until the third to the fourth postoperative day. Under conditions of the experiment we believe it justifiable to consider the differences in the measured induration of wounds sutured with the various materials directly attributable to the responses specifically incited by each material.

The curves presented indicate a significant difference in tissue reaction to the materials studied, the reaction to surgical gut being greatest, that to silk next and that to cotton least. It is reiterated that meticulous tissue technic must be employed in order that the tissue reaction to nonabsorbable materials be minimal, as here depicted.[4]

As has been indicated, at the end of the second month the degrees of induration among the three groups of wounds show little variance. This, we feel, cannot be interpreted to mean that there is no difference in value among the materials studied. In so far as local factors are concerned, it is the amount of reaction present during the period of active healing that determines the susceptibility of surgical wounds to complications.

## SUMMARY

1. A method for quantitative measurement of tissue reaction to suture materials is presented.

2. Comparative studies with the use of this method indicate a significantly greater tissue reaction to surgical gut than to cotton or silk and a significantly greater reaction to silk than to cotton.

4. Meade and Ochsner.[1b] Halstead.[2a] Whipple.[2d] Meade and Long.[3a]

# EXTENT OF STRANGULATION OF THE SMALL INTESTINE COMPATIBLE WITH LIFE

## Experimental Study

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P. A. PRITEL, M.D.
AND
R. L. MARSH, M.D.
LOS ANGELES

SUDDEN interference with the blood supply to the intestines in human beings occurs frequently and has a high mortality rate. The exact degree of acute decrease in blood supply that the human intestine can withstand and still retain viability is unknown. This question is of practical importance when encountered in conditions of strangulated intestinal obstruction, mesenteric thrombosis or embolism and in the preparation of the wall of the bowel for intestinal anastomosis. It is generally accepted that deficient blood supply is an important cause of marginal gangrene in a suture line.[1]

Welch and Mall [2] have shown that if more than 5 cm. of small intestine in the dog is deprived of arterial blood supply, the segment will undergo infarction and gangrene. Eisberg [3] also demonstrated that the blood entering through the intramural channels at each end of such a loop could maintain viability in the intestine only for a distance of 3 cm. Niederstien [4] found that severance of the mesentery of dogs for a distance of 3 cm. caused a superficial necrosis of the mucosa and that at 5 cm. hemorrhage also occurred into the other coats. He found that none of the animals died unless more than 5 cm.

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From the Hunterian Laboratory, the Department of Surgery and Graduate School of Medicine, College of Medical Evangelists.

Read by title before the Forum on Fundamental Surgical Problems, Clinical Congress of the American College of Surgeons, New York, September 1947.

1. Mollman, A. H.: End-to-End Anastomosis, J. Michigan M. Soc. **40**:882, 1941.

2. Welch, W. H., and Mall, F. P., in Allbutt, T. C.: System of Medicine, New York, The Macmillan Company, 1902, vol. 6.

3. Eisberg, H. B.: On the Viability of Intestine in Intestinal Obstruction, Ann. Surg. **81**:926, 1925.

4. Niederstien: Die Zirkulationstörungen im Mesenterialgebiet, Deutsche Ztschr. f. Chir. **85**:710, 1906.

was cut away, in which case a hemorrhagic infarct developed and death resulted. Schloffer [5] stated 3 cm. to be the margin of safety in rabbits. These experiments test the adequacy of the collateral circulation existing in the intestinal submucosa. Schloffer emphasized that not all lesions are fatal and many heal completely. Donaldson,[6] however, has pointed out that a somewhat longer segment of intestine can survive after venous occlusion alone than after arterial occlusion. Laufman [7] experimentally produced gradual complete occlusion of the superior mesenteric artery and vein, and the animals lived.

When the interference with the blood supply is gradual, an adequate collateral circulation can develop. However, when the blood supply through the intestinal arteries is suddenly shut off, the intestine has to rely entirely on the blood entering through the intramural channels. The present study was undertaken to determine the length of devascularized bowel which could be revascularized sufficiently to prevent gangrene and perforation.

## MATERIAL AND METHODS

Rabbits were the experimental animals selected because Noer [8] has shown that their mesenteric vascular pattern is more similar to that of human beings than the mesenteric vascular pattern of all other laboratory animals.

With aseptic precautions and under ether anesthesia, the ileum was exposed through an abdominal incision and different lengths of ileum were devascularized. The arcuate artery and vein and vasa rectae were doubly ligated at one point, and the vessels were cut between the ligatures. (No. 30 white cotton was used throughout.) The defect in the mesentery thus produced was carried right down to the wall of the bowel in one direction and in the opposite direction was brought to the intestinal artery and vein, which was also doubly ligated and cut between the ligatures. The defect in the mesentery was then carried to the arcuate vessels and vasa rectae of the opposite side, where the same procedure was carried out. The incision in the mesentery was again brought to the wall of the bowel, a triangular-shaped defect in the mesentery thus being produced. The mesentery was extremely thin, and therefore no attempt was made to close this triangular defect. At the close of the operation the only blood coming to the devascularized area was through the fine intramural vessels at each end of the ligated segment. (Dwight,[9]

5. Schloffer, H.: Ueber Darmstrikturen nach Unterbrechung der mesesenterialen Blutzufuhr, Mitt. a. d. Grenzgeb. d. Med. u. Chir. **14**:251, 1905.

6. Donaldson, J. K.: A Neglected Type of Venous Mesenteric Occlusion, read before the American College of Surgeons, Boston, November 1941.

7. Laufman, H.: Gradual Occlusion of the Mesenteric Vessels, Surgery **13**:406, 1943.

8. Noer, R. J.: The Blood Vessels of Jejunum and Ileum: A Comparative Study of Man and Certain Laboratory Animals, Am. J. Anat. **73**:293, 1943.

9. Dwight, T.: Proceedings of the Tenth Annual Session Association of American Anatomists, 1897; cited by Eisberg.[2]

Monks [10] and Mall [11] have demonstrated free anastomosis within the wall of the bowel.) The lesion thus produced resembles closely that which occurs in man when an embolus lodges in one of the smaller intestinal arteries and a thrombus forms in all the terminal branches as far as the mesenteric attachment to the wall of the bowel. The devascularized loops were returned to the abdomen, which was then closed in the usual manner.

Seven groups of animals were operated on, and increasing lengths of ileum were devascularized as shown in the table.

The operative site was examined at autopsy, after the animal was killed, or at a subsequent exploratory operation.

## RESULTS

*Group 1 (Devascularization of 5 Cm. of Ileum in 2 Rabbits).*—These rabbits had a normal postoperative course, and at exploratory laparotomy ten days later the ligated area appeared essentially normal.

*Group 2 (Devascularization of 6 Cm. of Ileum in 10 Rabbits).*—One rabbit died on the fifth postoperative day. Autopsy showed the ligated area to be blanched but not gangrenous or perforated. There

*Length of Devascularized Areas in Rabbits*

| Group | Number of Rabbits Operated on | Length of Devascularized Area, Cm. |
|---|---|---|
| 1 | 2 | 5 |
| 2 | 10 | 6 |
| 3 | 12 | 7 |
| 4 | 10 | 7½ |
| 5 | 10 | 8½ |
| 6 | 10 | 10 |
| 7 | 2 | 13 |

was diffuse peritonitis, but the origin was not clear. One animal was killed after five weeks. Autopsy showed that the ligated loop had become adherent to itself and to adjacent loops of small intestine. The defect in the mesentery had closed spontaneously. Revascularization had occurred from adjacent loops, from the omentum and from adhesions to the parietal peritoneum. The remainder of the animals are living and well.

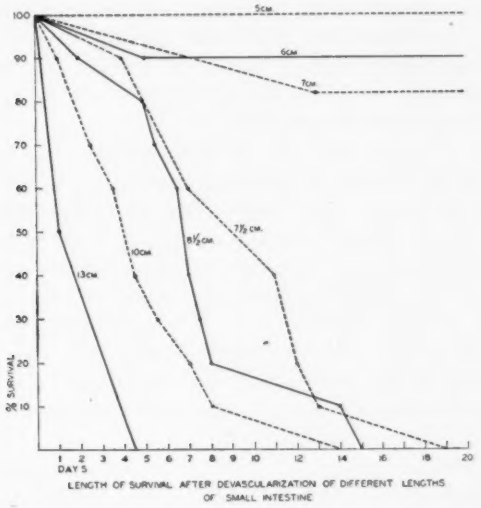
*Group 3 (Devascularization of 7 Cm. of Ileum in 12 Rabbits).*—Exploratory laparotomy on 1 rabbit on the tenth postoperative day showed a large abscess which resulted from a perforation in the devascularized area of the intestine. The abscess was drained and the perforation closed, and the rabbit recovered. Our experience with this type of lesion has been that the perforation in the intestine continues to feed the abscess, which grows and eventually ruptures,

10. Monks, G. H.: Intestinal Localization, Ann. Surg. **38**:574, 1903; cited by Eisberg.[3]

11. Mall, F. P.: Die Blut-und Lymphwege im Dünndarm des Hundes, Abhandl. d. math.-phys. Cl. d. k. sächs. Gesellsch. d. Wissensch., 1887; cited by Eisberg.[3]

and produces peritonitis, with a fatal termination. We are therefore counting the occurrence in this animal as a fatality, which would undoubtedly have been the outcome were it not for the operative intervention. One rabbit died on the thirteenth postoperative day from an unrelated condition. One rabbit was killed after five weeks, and the findings at autopsy were the same as in group 2. The remainder of the animals are living and well.

*Group 4 (Devascularization of 7.5 Cm. of Ileum in 10 Rabbits).*—In this group the mortality rate rose sharply (see chart). All the rabbits were dead by the nineteenth day. The autopsy showed that




Length of survival after devascularization of different lengths of small intestine.

perforation and peritonitis were the cause of death in 80 per cent of them. In the remainder, death was not definitely related to the operative procedure. The average length of survival for all the animals in the group was 9.2 days.

*Group 5 (Devascularization of 8.5 Cm. of Ileum in 10 Rabbits).*—The chart shows a shortened duration of life for this group. All the rabbits were dead by the fifteenth day. Autopsy showed gangrene, perforation and peritonitis to be the cause of death in 100 per cent. The average length of survival for this group was 7.7 days.

*Group 6 (Devascularization of 10 Cm. of Ileum in 10 Rabbits).*—The length of survival after devascularization was still further reduced,

as shown by the chart. The findings at autopsy were the same as in group 5. The average length of survival was 5.2 days.

*Group 7 (Devascularization of 13 Cm. of Ileum in 2 Rabbits).*—One rabbit died twenty-four hours after operation and the second rabbit four and a half days after operation. The findings at autopsy were the same as in group 5. The average length of survival was 2.8 days.

## COMMENT

The sudden removal of the blood supply of 5 cm., 6 cm. and 7 cm. lengths of the small intestine is compatible with life in the rabbit. When larger segments of small intestine were devascularized, gangrene, perforation, peritonitis and death was the usual course of events. It was surprising to observe that some animals with such lengths of devascularized intestine as 8.5 cm. and 10 cm. could survive eight, ten, twelve and even fourteen days.

When 5 cm. of intestine was devascularized, the intestine was able to maintain viability by the blood entering through the intramural vessels at each end. When longer areas were devascularized, however, this was insufficient to maintain viability, and the blood supply was seen to come from four sources: (1) adherent, adjacent loops of intestine, (2) ingrowth of new blood vessels into the closed, healed mesentery, (3) the omentum and (4) vascularized adhesions to the parietal peritoneum. These methods of revascularization are graphically demonstrated in an article recently published.[12] The well known protective effect of the omentum in helping to revascularize an injured area is experimentally demonstrated.

These experiments closely reproduce the condition that exists in acute mesenteric thrombosis or embolism, in strangulated intestinal obstruction and in stab wounds of the mesentery. It is well known [13] that there are many cases of mesenteric thrombosis or embolism that go undiagnosed. Recovery without operation does not exclude the diagnosis of thrombosis or embolism of the superior mesenteric vessels or their branches. In this process the role of the omentum is self evident, not only in walling off infection but also in aiding revascularization.

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12. Davis, H. A.; Gaster, J.; Marsh, R. L., and Pritel, P. A.: The Effect of Streptomycin in Experimental Strangulation of the Small Intestine, Surg., Gynec. & Obst. **87**:63, 1948.

13. Klein, E.: Embolism and Thrombosis of Superior Mesentric Artery, Surg., Gynec. & Obst. **33**:385, 1921.

SUMMARY

Devascularization of small intestinal loops up to 7 cm. in length was compatible with life. Removal of the blood supply to areas of bowel more than 7 cm. in length usually caused death from gangrene and perforation of the affected loop. The duration of life after devascularization of the bowel is inversely proportional to the extent of bowel which has been deprived of its blood supply.

# OSTEOID OSTEOMA

## Report of a Case with Probable Double Lesion

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OSTEOID osteoma was first described in detail by Jaffe [1] as a definite clinical entity in 1935. He considered it to be "a benign osteogenic tumor of slow growth."

Prior to Jaffe's paper, this lesion had apparently been diagnosed as "sclerosing nonsuppurative osteomyelitis," "chronic sclerosing osteitis" (Henderson,[2] 1924), and "sclerosing osteomyelitis of Garré" (Ewing, 1942, and Wishner,[3] 1933). The sclerosing osteomyelitis described by Garré [4] in 1891 most probably also represented the osteoid osteoma.

Quite a few cases of osteoid osteoma have been recorded subsequent to Jaffe's publication.[4a] However, this condition, which is not extremely rare, still not infrequently remains unrecognized. The authors wish to record a case apparently presenting two osteoid osteomas, one in the neck and another in the shaft of the right femur of the same patient. In all cases thus far reported a single lesion was present, and there-

From the service of Dr. Leo Mayer and Dr. Henry Milch, Hospital for Joint Diseases, and the service of Dr. A. Bingham, New York Medical College, Flower and Fifth Avenue Hospitals.

1. Jaffe, H. L.: Osteoid Osteoma: A Benign Osteoblastic Tumor Composed of Osteoid and Atypical Bone, Arch. Surg. **31**:709-728 (Nov.) 1935.

2. Henderson, M. S.: Chronic Sclerosing Osteitis, J. A. M. A. **82**:845-942 (March 15) 1924.

3. Wishner, J. G.: Chronic Sclerosing Osteomyelitis (Garré), J. Bone & Joint Surg. **15**:723-732 (July) 1933.

4. Garré, C.: Einige seltene Erscheinungsformen der akuten infektiösen Osteomyelitis: Festschrift zum 25 jährigen Doktor-und Dozenten-Jubiläum von Theodor Kocher, Wiesbaden, J. F. Bergman, 1891, vol. 1, p. 43; Ueber besondere Formen und Folgezustände der akuten infektiösen Osteomyelitis, Beitr. z. klin. Chir. **10**:241, 1893.

4a. Wallace, G. T.: Some Surgical Aspects of Osteoid Osteoma, J. Bone & Joint Surg. **29**:797-780 (July) 1947. Jaffe, H. L., and Lichtenstein, L.: Osteoid Osteoma: Further Experience with This Benign Tumor of Bone with Special Reference to Cases Showing the Relation to Shaft Cortices and Commonly Misclassified as Instances of Sclerosing Non-Suppurative Osteomyelitis of Cortical Bone Abscess, ibid. **22**:645-682 (July) 1940.

fore our case must be considered the first on the record in which there was probable double lesion.

### CLINICAL PICTURE

Osteoid osteoma is apparently a benign localized bone tumor. It occurs mostly in children or young adults, male or female. It is not associated with fever.

Ponseti and Barta [5] reported a lesion in the lower end of the fibula in a 14 month old girl with symptoms present since the age of 10 months. Hamilton [6] and one of us (P. W. L.[6a]) recorded an osteoid osteoma of the neck of the talus in a 40 year old woman and of the neck of the femur in a 40 year old man respectively.

The patient usually complains of recurrent attacks of dull ache, mostly at night, not aggravated by activity. The pain is promptly relieved by acetylsalicylic acid, and many patients carry tablets and take them periodically at the onset of pain.

There may be local tenderness and occasional swelling. Limp and limitation of motion may be present from a periarticular lesion (Sherman [7]). Torticollis was noted in the involvement of cervical vertebra, scoliosis in a case of a lesion of the ninth rib, varus deformity of the foot with the lesion in the lower end of the fibula and medial bowing of the leg due to osteoid osteoma in the upper medial region of the tibia, reported by Ponseti and Barta.

The lesion may be localized in almost any long or cancellous bone, although it seems to favor certain parts of the skeleton, such as the shaft of the tibia, lower portion of the neck of the femur, anterior part of the os calcis, vertebral laminas, upper part of the neck of the talus, phalanges of the feet and hands and tarsal and carpal navicular bones. Osteoid osteoma has also been found in the pelvis, skull, humerus, radius, ulna, rib, femoral condyles and patella.

Roentgenograms are often characteristic and suggestive of the lesion. There is an area of dense, sclerosed bone in the middle of which a small round nidus of rarefaction is found. Sometimes the nidus itself is surrounded with a thin circle of radiotranslucency. The sclerosing changes may be extensive in the case of involvement of the long bones, and may often obscure the nidus. Several slightly overexposed roent-

5. Ponseti, I., and Barta, C. K.: Osteoid Osteoma, J. Bone & Joint Surg. **29**:767-776 (July) 1947.

6. Hamilton, J. F.: Osteoid Osteoma with Case Reports, Surg., Gynec. & Obst. **81**:465-474 (Nov.) 1945.

6a. Lapidus, P. W., and Wilson, M. J.: Osteoid Osteoma: Report of Three Cases, Bull. New York M. Coll., Flower & Fifth Ave. Hosps. **37**:44, 1947.

7. Sherman, M.: Osteoid Osteoma Associated with Changes in Adjacent Joint: Report of Two Cases, J. Bone & Joint Surg. **29**:483-490 (April) 1947.

genograms from different angles may be necessary before the nidus may be visualized.

As shown by MacKenzie [8] and others, the roentgenographic changes are slowly progressing and the nidus may become visible only in the later stage of the illness. Laboratory examinations of urine, blood (including sedimentation rate), calcium, phosphorus and phosphatase have always shown these to be normal. Likewise the cultures from the lesion have always remained sterile.

The pathologic picture is also characteristic. Macroscopically, in fresh specimen there is a reddish round area about 0.5 to 1.0 cm. in diameter, sharply demarcated from the yellowish surrounding bone (figs. 2 and 5 *A*). On microscopic section the nidus consists of a vascular, richly cellular embryonal type of osteoid tissue containing osteoblasts and osteoclasts. Often the nidus may be found only after thorough sectioning of the entire specimen.

It is helpful, for confirmation of the diagnosis, to take roentgenograms of the specimen from different angles. On some views the nidus may be well noticeable, while on others it may be completely overlapped by the sclerosed bone (fig. 3).

The osteoid osteoma, as has already been stated, always has a benign course. Metasis of the lesion has never been observed.

Thorough surgical removal of the lesion together with a block of surrounding bone is the only treatment thus far tried and brings prompt relief. The typical pain is promptly terminated immediately after the operation, and recurrence of the lesion has never been observed. There are, however, a few cases on record in which symptoms persisted because of failure to locate and remove the nidus or because of incomplete removal. In order to avoid these mistakes, it is advisable to take roentgenograms during the operation to assure adequate location and removal of the osteoid osteoma with the surrounding bone.

## REPORT OF A CASE

T. B., a 16½ year old white male student, was referred to the office of one of the authors (P. W. L.) by his family physician on Sept. 12, 1946, because of dull, aching pain over the anterolateral aspect of the right thigh, of three or four months' duration. The pain was mostly at night and during the cold rainy weather, and it had become more severe during the last month, preventing him from resting at night. The boy had lost 5 or 6 pounds (2.3 to 2.7 Kg.) during the last three months. The pain was promptly relieved by taking acetylsalicylic acid and was not aggravated by physical activities.

About one year prior to the consultation, while playing baketball, the patient was hit over the right thigh by the head of another player. He was slightly lame

8. MacKenzie, W.: Painful, Non-Suppurative Sclerosis of the Long Bones, J. Bone & Joint Surg. **29**:49-58 (Jan.) 1947.

for one week after the injury. Physical examination was essentially noncontributory. There was no limp. The boy was able to hop on each foot and could squat without discomfort. There was no muscular atrophy of the lower limbs, and no tenderness could be found. No sensory changes were present, and the deep reflexes

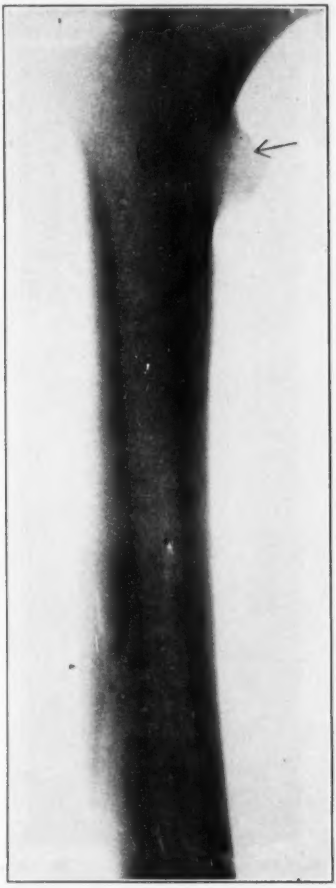

Fig. 1.—Roentgenogram of the right femur. Note considerable sclerosing changes over lateral aspect of the shaft, with what appeared to be a nidus (small arrows) on close study. There seem to be no changes over the upper part of the femur (large arrow).

were equal and normal. The following note was made on the office chart (P. W. L.) after the first examination: "In spite of the practically negative clinical findings the picture is very much suggestive of osteoid osteoma of the shaft of the femur."

The patient was referred to Dr. C. Gottleib for roentgenographic study.

During the second office visit, on Sept. 16, 1946, a slight limp was noted on the right side. Roentgenograms of the right femur showed a localized sclerosing cortical area up to three quarters of an inch thick (1.9 cm.) over the lateral aspect at the junction of the upper and middle thirds (fig. 1). The roentgenologist reported "periosteal proliferation at the lateral portion of the middle third of the

Fig. 2.—Photograph of the specimen removed at the second operation. Arrows show the nidus. Note that there are several large blood vessels at and around the nidus.

right femur. Since it is at the site of the trauma, it may be of traumatic origin. It does not have the appearance of neoplasm."

However, after thorough study of roentgenograms "a round area the size of a pea, which is surrounded by a thin line of translucent bone which might represent an osteoid osteoma" in the center of the sclerotic area was recorded on the office

chart of one of us (P. W. L.), and a clinical diagnosis of osteoid osteoma of the midshaft of the right femur was confirmed (fig. 1, small arrows).

The patient continued to have attacks of rather severe, mostly nocturnal pain, which was controlled by the use of acetylsalicylic acid.

He was admitted to New York Medical College, Flower and Fifth Avenue Hospitals, on Sept. 23, 1946. Results of physical examination, including the laboratory study, were entirely negative. The patient's temperature, pulse and respiration were normal. A Wassermann test of the blood gave negative results. The hemoglobin content was 100 per cent, 15.6 Gm. per hundred cubic centimeters. The red blood cell count was 5,400,000 and the white blood cell count 9,200, with 64 per cent neutrophils, 2 per cent eosinophils and 34 per cent lymphocytes. The sedimentation rate (Westergren) was 4 mm. in sixty minutes. The blood calcium was

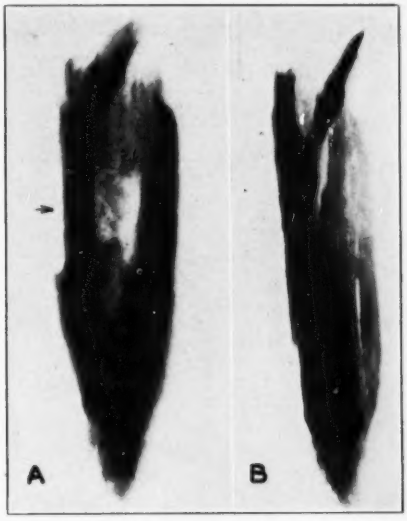


Fig. 3.—*A*, roentgenogram of the same specimen showing the nidus (arrows). *B* lateral view of the same specimen with the nidus being overlapped by the sclerosed bone and not visible. This may explain the frequent difficulty in visualizing the nidus.

10.82 mg. and the phosphorus 3.19 mg. per hundred milligrams. The value for alkaline phosphatase was 11.6 and for acid phosphatase 4.4. The urine was normal.

At the operation performed by the senior author (P. W. L.) on Sept. 24, 1946, a sharp exostosis shaped like an old-fashioned razor blade, with its broad base attached to the anterior lateral surface of the femoral shaft and its sharp edge protruding anteriorly and medially, and being parallel to the femoral shaft, was found. The exostosis terminated distally in a sharp, spearlike point. The entire exostosis was removed together with a piece of sclerosed cortex about 2½ inches (6.3 cm.) long and 0.5 inch (1.2 cm.) wide.

The day after the operation the patient reported that he had "no usual pain last night." On the ninth postoperative day (Oct. 3, 1946) he stated that "pushing" preoperative pain had disappeared, but he felt "throbbing, drawing pain."

The postoperative recovery was uneventful. The wound healed per primum, and the patient left the hospital on Oct. 20, 1946, after about a four weeks' stay. The pathologic study of all the removed bone fragments by Dr. G. K. Higgins, professor of pathology, on "numerous sections, failed to reveal the changes in the bone which characterize osteoid osteoma." Likewise, the roentgenograms of these bone fragments failed to show any lesion.

Fig. 4.—Roentgenogram of the upper part of the right femur showing periosteal proliferation (large arrows) and a nidus (small arrows) in the center of sclerosed bone.

After discharge from the hospital, the patient continued to have attacks of pain, mostly nocturnal, over the lateral aspect of the right thigh, which required one tablet of acetylsalicylic acid in every four hours. The roentgenograms of the right femur showed postoperative bone defect, but no definite nidus could be made out although "in one spot over the upper part of the defect a suspicious area" seemed to be present. There was practically no local tenderness on pressure. It was thought that the osteoid osteoma was not removed.

On Nov. 12, 1946, the patient was readmitted to New York Medical College. Flower and Fifth Avenue Hospitals. The clinical and laboratory findings were again negative, except that there were slight atrophy of the right thigh and slight limitation of flexion of the right knee and the right knee jerk was now absent.

On November 13 a second operation was performed (P. W. L.). A large bone block, 3¼ inches (8.2 cm.) long and 1 inch (2.5 cm.) wide was removed through the entire cortex down to the bone marrow. A nidus the size of a pea was found in the upper portion of the removed bone (fig. 2). Dr. G. K. Higgins,

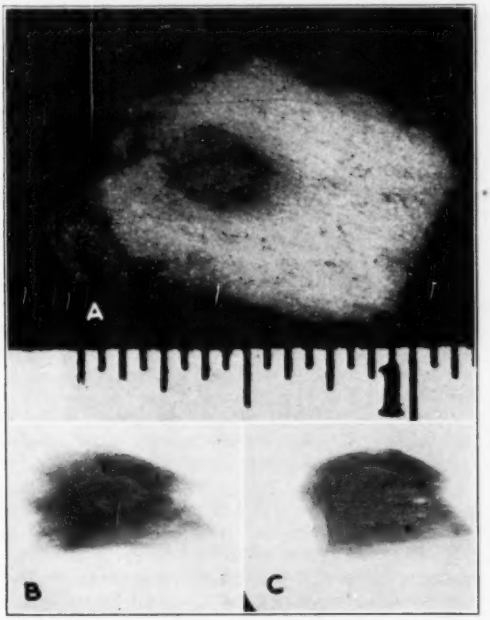


Fig. 5.—*A*, photograph of the specimen removed near the lesser trochanter showing typical osteoid osteoma. *B*, roentgenogram of the same specimen showing the nidus (arrows). *C*, different view of the same specimen, on which the nidus is not so well demonstrable. Note several blood vessels around and in the center of the nidus.

after macroscopic examination of the specimen, reported "osteoid osteoma (gross diagnosis)" and considered the changes typical. Unfortunately no microscopic examination could be made, since the specimen became deteriorated after prolonged decalcification. Roentgenograms of the removed specimen showed a round area of rarefraction also typical of osteoid osteoma (fig. 3*A*).

The patient made uneventful postoperative recovery and was discharged on the seventh postoperative day (November 20). For the first two days after the operation he seemed to be relieved; later on, however, his local pain recurred and even became more intense, requiring four or five tablets of acetylsalicylic acid every twenty-four hours. At first the patient localized his pain over the lower two

thirds of the right thigh. On November 29 a sudden attack of "severe pain which was localized in the right knee" and disappeared within ten minutes after a tablet of acetylsalicylic acid was taken was recorded on the office chart (P. W. L.). Since one of us (P. W. L.) was reasonably sure that he succeeded in removing the entire lesion at the second operation, he was baffled by the persistence of severe pain.

The patient was hospitalized for the third time, this time as a ward patient on the service of Dr. L. Mayer and Dr. H. Milch at the Hospital for Joint Diseases, on Feb. 13, 1947. He still complained of dull, aching pain over the lateral aspect of the right thigh and sometimes in the right knee. Pain recurred every four hours regardless of activity or rest, and was relieved by a tablet of acetylsalicylic acid.

Roentgenograms of the middle third of the right femur (Feb. 17, 1947) were reported by Dr. M. Pomeranz as showing "several sclerotic nubbins within the excavated area which may represent the original osteoid osteoma." The roentgenologist's report on February 20 read as follows: "Planigraphic films reveal several circular densities at the base of the excavated area (site of previous operation) which probably represent a residuum of osteoid osteoma. Examination of the right hip joint discloses an irregular periostitis and thickening of the lesser trochanter of the femur. The cortex is moderately eburnated and thickened, and within it a linear nubbin of bone is noted which is likewise strongly suggestive of an osteoid osteoma" (fig. 4). The same changs over the lesser trochanter were noted by Dr. M. Pomeranz on several subsequent roentgenograms.

During extensive preoperative observation one of us (E. P. S.), then a resident surgeon, pointed out that "there may be increased tenderness which is localized approximately at the level of the lesser trochanter." Slight limitation of motion in the right hip joint was also observed by a few members of the staff, some of which even considered the possibility of a "psychogenic origin" of pain.

On February 25 infiltration with 30 cc. of 1 per cent procaine hydrochloride solution along the lateral aspect of the femur at the site of previous operation was performed at the height of the attack of pain, and the patient was not allowed to take his usual dose of acetylsalicylic acid. After this, complete relief of pain in the right thigh and knee was obtained. This lasted for over fifteen minutes, and then pain recurred; the patient was permitted to take acetylsalicylic acid, and within half an hour all symptoms had subsided. The next day the same infiltration, but with sterile water, failed to give him any relief. Similar infiltration with procaine hydrochloride solution was carried out with the point of the needle at the lesser trochanter under roentgen ray control, and again the patient was relieved from pain for about twenty minutes, after which the pain recurred in the knee, but not in the thigh, and again disappeared thirty mniutes after a tablet of acetylsalicylic acid was taken.

These procedures seemed to exclude psychogenic origin of the pain but were inconclusiye concerning the location of the lesion. The staff was divided in two groups, one (including P. W. L.) suspecting persistence of the lesion over the femoral shaft previously operated on, and another, including Dr. L. Mayer, believing the symptoms to be due to an osteoid osteoma at the lesser trochanter. (One of us, E. P. S., was especially emphatic in the latter interpretation, for which the senior author wishes to give him due credit).

Finally, it was decided to explore first the region of the lesser trochanter and, if no osteoid osteoma was found there, to expose again the lateral aspect of the femoral shaft.

On March 3, 1947, the region of the lesser trochanter of the right femur was explored. Periosteal roughening was found over the anterior aspect of the femur at the base of the lesser trochanter. A block of bone about 1 inch (2.5 cm.) long

and 0.75 inch (1.9 cm.) wide was removed over the roughened area. A definite nidus obviously representing osteoid osteoma was found on its deep surface, on the lifting of the block of bone (fig. 5 *A*). Roentgenograms taken at the operation showed removal of the bone at the site of the lesion.

The patient made satisfactory postoperative recovery. His "typical pain" disappeared the day after the operation, and he has remained entirely free of pain.

Pathologic examination of the specimen by Dr. H. L. Jaffe was reported to show typical "osteoid osteoma." The roentgenograms of the specimen also showed the typical picture of osteoid osteoma (fig. 5 *B* and *C*).

When last seen in the office, on Aug. 28, 1947 (six months after the last operation), the patient was completely asymptomatic; he gained 30 pounds (13.6 Kg.) and has been indulging in athletics.[9] There was normal function of the right lower limb, although it still showed some muscular atrophy, and the right knee jerk was still absent.

Roentgenograms of the right hip and right femoral shaft showed filling of the bone defect in both places, with diminution of the sclerosing area over the femoral shaft.

## COMMENT

In all up-to-date recorded cases of osteoid osteoma a single lesion was present. Therefore, our case seems to be the first on record in which an apparently double lesion was present. It is of course fully realized by us that this case cannot be considered as one in which there was a definitely proved double lesion because of the most unfortunate lack of microscopic diagnosis of the specimen removed at the second operation. However, the typical appearance of this specimen (fig. 2), which was macroscopically diagnosed as unquestionable osteoid osteoma by Dr. G. K. Higgins, Professor of Pathology of New York Medical College, and most typical roentgenograms of the specimen (fig. 3 *A*) together with the clinical picture and the presence of definitely proved osteoid osteoma over the lesser trochanter seem to justify our assumption that the lesion over the lateral aspect of the femur was also an osteoid osteoma.

## SUMMARY

Osteoid osteoma is a benign, slowly growing bone tumor. Its clinical symptoms and treatment are briefly discussed. All cases recorded thus far presented a single osteoid osteoma. A case is reported which is the first on record in which there was an apparently double lesion—one, definitely proved, over the lesser trochanter of the femur and another over the lateral aspect of the shaft of the same femur, inadvertently not confirmed microscopically. Symptoms persisted after removal of the lesion over the femoral shaft, and only after removal of the osteoid osteoma near the lesser trochanter was complete relief obtained.

9. Up to the time this proof was read, Feb. 3, 1949, the patient has remained perfectly well.

# Surgical Clinics

## CYSTIC EMPHYSEMA OF THE LUNGS

W. EMORY BURNETT, M.D., AND STAFF, OF THE TEMPLE UNIVERSITY MEDICAL SCHOOL
PHILADELPHIA

The Chest Conference, held in the X-Ray Museum, Temple University School of Medicine, Philadelphia, convened at 5:10 p. m., Chairman W. Edward Chamberlain presiding.

DR. CHAMBERLAIN: May I call the Chest Conference to order and say that today's conference is being recorded by stenotype to be transcribed for publication? For that reason, I would ask everyone to speak distinctly and to the point. As usual, our discussion will be extemporaneous, but we should be brief.

Will you introduce the case of J. T., Dr. Rosemond?

DR. ROSEMOND: J. T. is a 42 year old man. He was admitted for investigation of pulmonary complaints. He states that for the past seven years he has had increasing dyspnea on exertion, associated with chronic productive cough, but no hemoptysis or pain in the chest. His attacks of dyspnea responded to epinephrine hydrochloride for a time but no longer do so. Skin tests revealed allergy to ragweed, house dust and milk. Dyspnea has become markedly increased in the past few months. The patient has lost approximately 50 pounds (22.7 kg.) in weight.

A cholecystectomy for chronic calculus cholecystitis was performed under spinal anesthesia two months before this admission. The patient recovered from this without difficulty.

On physical examination, he appeared to be a man of average development but in some respiratory distress, even while lying quietly in bed with the head elevated. There were evidence of recent loss of weight, slight bilateral cervical lymphadenopathy and signs of emphysema bilaterally in the chest, with retraction in the supraclavicular and suprasternal regions on inspiration. The trachea was deviated to the right. There were dry rales at both bases. The rate and rhythm of the heart were normal. Abdominal examination revealed nothing abnormal except for a transverse scar in the upper right quadrant. There was no edema of the ankles, and the blood pressure was 102 systolic and 70 diastolic. The blood count on his admission to the hospital and the urine were normal. Examinations of the sputum revealed no acid-fast rods. Examination of the electrocardiographic study of the heart showed no evidence of disease. The patient was afebrile on admission.

DR. CHAMBERLAIN: Our first roentgenologic study of this man is dated Dec. 26, 1946, at which time we visualized emphysematous blebs in both lungs. The important thing to remember about roentgenologic studies in this condition of bullous emphysema or of emphysematous blebs is that there is usually much more pathologic change than shows on the roentgenograms. We do not expect to visualize all these thin-walled bullae or blebs. One does pick them up by the visualization of their walls and by margins of spherical spaces which are seen here and there.

It takes only a moment to notice that there are some large blebs showing in the lateral projection that are not visible in the ventral projection. We are not

able to check the ventral projection against the lateral with any degree of complete correlation. That in itself indicates that there is more present in the way of emphysematous blebs than one would expect from just a cursory reading of the roentgenograms.

When the patient was reexamined on Feb. 7, 1947 (fig. 1*A*), the roentgen appearance had not changed measurably. The most recent roentgenograms, of Oct. 22, 1947 (fig. 1*B*), show rather a thinner wall around the biggest bleb at the base of the right lung, and some thin lines here and there, which indicate

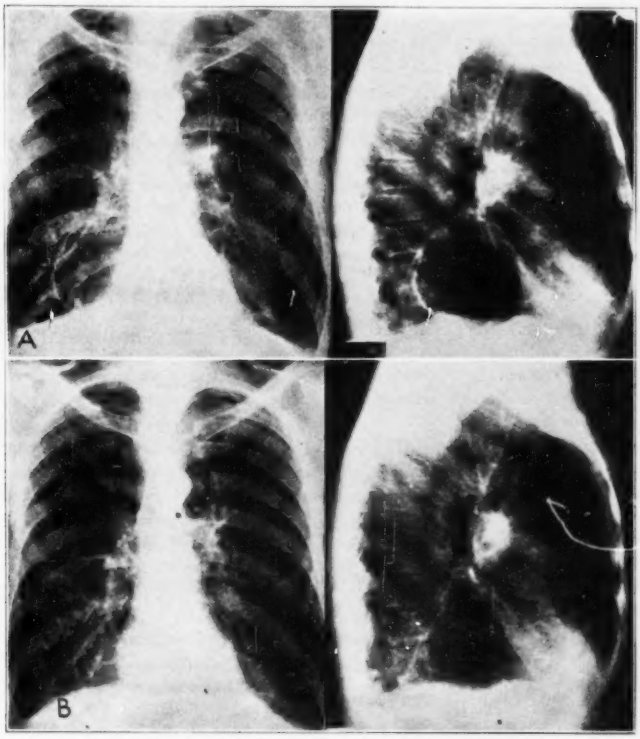


Fig. 1 (case 1, J. T.).—*A*, Feb. 7, 1947. Ventral and right lateral projections showing bullous emphysema of both lungs. "Blebs" of all sizes are seen. Many of those seen in the lateral projections elude identification in the ventral projection and vice versa. *B*, Oct. 22, 1947. Many of the blebs show thinner walls than were manifest on the February roentgenograms. This is believed to indicate a decrease in the element of infection.

a widespread involvement; in other words, there are blebs elsewhere than at the place where a definite margin is seen. Again, in the lateral projection, we note evidence of sizable blebs that are not seen with the ventral projection.

The most recent roentgenograms suggest that there is less infection than there was at the examination of Feb. 7, 1947, and earlier. That is because the walls have become thinner; the blebs are much more thin walled than they were. I suspect that the element of infection has quieted down a lot, but I do not think that the mechanical situation has changed in any way.

What about bronchoscopy, Dr. Norris?

DR. NORRIS: Bronchoscopy in this case showed nothing except diffuse inflammatory changes bilaterally and a little tenacious mucoid secretion. There was nothing obstructive anywhere in the accessible bronchial tree. We obtained a specimen for culture.

DR. CHAMBERLAIN: That was sent for bacteriologic study.

Dr. Spaulding, do you have the reports for J. T.?

DR. SPAULDING: I have records of two sputum cultures. One contained hemolytic streptococci and pneumococcus type 13; the other showed type 28 pneumococcus and diphtheroids. Thus, three different organisms were isolated, and the two cultures were different. The higher types of pneumococcus are generally considered insignificant, and since the streptococcus is not designated as belonging to group A, neither organism is a primary pathogen. The diphtheroid is not pathogenic. Although we have not excluded the possibility that these organisms may have played a role in this case, the findings are not clearcut.

DR. CHAMBERLAIN: Dr. Burnett, what is your comment on this case?

DR. BURNETT: We felt that the mechanical phase was of questionable importance and that bronchospasm, allergy and cardiac function might be contributory. I asked Dr. Durant to examine the patient from the medical angle and to review the cardiac findings. Dr. Durant, would you express your opinion of this patient?

DR. DURANT: I saw him on February 17, and at that time he gave a history of having had considerable quantities of purulent sputum and did not remember how far back the expectoration began but knew it had been present for a considerable period. His asthmatic breathing had been largely due to expiratory difficulty and had been relieved promptly by administration of epinephrine hydrochloride. I think that is a feature that is frequently seen in these cases. The bronchospastic features are often relieved by the usual bronchodilators, and such, "luasmin," were prescribed.

It was my impression that the amount of purulent sputum here was suggestive of suppurative pneumonitis, probably secondary to the cystic disease. This could in turn be responsible for the asthmatic breathing on the basis of bacterial sensitization. I suggested mapping the right lung to determine the presence of bronchiectasis. His cardiac status was entirely satisfactory.

DR. CHAMBERLAIN: "Lipiodol" bronchography has not been used in examination of this man's chest. The element of pneumonitis cleared up pretty rapidly, and there is much less evidence of abnormality in the more recent roentgenograms. I think, of course, that the chest should be mapped if surgical intervention is going to be considered. The first question which the surgeons wish us to help to decide is whether this is a suitable case for surgical treatment. Of course, the question in my mind arises from the diffuse involvement. We know that there are blebs in many areas and probably others that do not show on the roentgenogram.

DR. BURNETT: We feel, too, that the bronchospasm is a big element in the production of this type of cyst or bulla and of the blebs under the pleura. We felt that there was a certain amount of infection, as indicated by his symptoms and by the roentgenograms. It was because of that and of the results of studies of the pulmonary functions, which I will give in a moment, that "lipiodol" was not used, the reason being that we would be unable to follow the minor changes if a good deal of "lipiodol" were trapped in the alveoli. We were not at that time ready to subject the patient to surgical treatment. We were not even certain that he should be subjected to surgical intervention at any time, but we discussed with him the fact that if we did advise removal of some of these large bullae to improve the expansion and aeration it might be combined with sympathectomy or denervation of the hilus, with the hope of decreasing the secretion or spasm of the bronchi.

Before going further, let us give you the results of spirometric studies. Dr. Oppenheimer!

DR. OPPENHEIMER: External spiromatic studies gave the oxygen consumption as 166 cc. per minute; rate, 9; tidal volume, 775 cc.; minute volume, 7 liters; ventilation equivalent, 4.2; maximal breathing capacity, 11.2, and reserve, 38 per cent, which is low, 75 being normal.

Bronchospirometric study of the right side showed an oxygen uptake of 540 cc. per minute, the uptake on this side being 74 per cent of the total, as compared to 26 per cent on the left side. The tidal volume was 350 cc., the minute volume 5.9 liters and the ventilation equivalent 1.1.

On the left side the oxygen uptake was 190 cc., representing 26 per cent of the total, and the rate 17; the tidal volume on this side was less than 250 cc., the minute volume 4.2 liters and the ventilation equivalent 2.2.

Spirometric study indicates a poor pulmonary function, with an increased ventilation equivalent indicating less than normal efficiency and with a low reserve.

DR. CHAMBERLAIN: Dr. Oppenheimer, the utilization of oxygen was three times as great on the right side as on the left?

DR. OPPENHEIMER: Approximately, yes—74 per cent on the right and 26 per cent on the left. The tidal volume on the right was 350 cc. and on the left 250 cc., both greatly diminished.

DR. CHAMBERLAIN: I am interested in that. It emphasizes the point made earlier, namely, that the roentgenogram does not show everything that is important in a case of this sort. Here we have three times as much respiratory function on the right as on the left, and from the standpoint of the roentgen findings, you would perhaps say that the greatest involvement was on the right instead of on the left. It shows that there are a lot of changes in this left lung that are not shown on the roentgenogram.

DR. BURNETT: That was another thing that made us question the value of surgical extirpation—the right lung, which appears worse, was doing most of the work. By the way, the studies of pulmonary function were checked and found similar. So the question was whether or not we should continue with the present course or subject this man to a combination of extirpation of the large cysts and sympathectomy or vagectomy of the posterior pulmonary plexus, which could be done at the same time but would have to be done bilaterally eventually to be of much value to him.

On treatment with "luasmin" and inhalation of penicillin, he has improved considerably, although we have not a check-up of pulmonary function, unfortu-

nately. We will get one at an early date. Clinical evaluation shows that he is able to do more and has returned to work as a street car conductor, which, of course, is not a very active occupation. He feels definitely better. His respiratory reserve seems to be somewhat improved, and he looks better and has gained about 12 pounds (5.4 Kg.) in weight. So I think he has improved considerably, and I request the opinon of the Conference as to whether he should continue this program, or whether we should subject him to surgical extirpation of the large bullae.

DR. CHAMBERLAIN: Dr. Oppenheimer, did you give us the date of your studies of pulmonary function?

DR. OPPENHEIMER: February 12.

DR. CHAMBERLAIN: In view of the improvement in the roentgen appearance, not of the mechanical situation but of the element of infection, as shown by the more recent roentgenograms, I would certainly want to see a repetition of those functional studies before we make any final decision in this case. Dr. Burnett, you and I felt that the Conference would gain from a consideration of the cases of H. S., F. S. and E. N. and of some of the other cases of bullous emphysema because they point up the propriety or impropriety of surgical intervention in a case of this sort. Shall we ask the members of the Conference to make their recommendation in this case of J. T. after a discussion of some of these other cases that we want to review today?

DR. BURNETT: I think that will give them additional evidence.

DR. CHAMBERLAIN: This next case, which is somewhat comparable, is that of E. N. Dr. Rosemond, will you introduce the history?

DR. ROSEMOND: Mrs. E. N., a 36 year old white woman, was admitted with a five week history of cough, increasing dyspnea, nausea, vomiting and loss of weight. The cough had become more irritating and was productive at the time of admission. The onset of these symptoms began rather suddenly with a pain in the right side of the chest which was accentuated by deep breathing. The cough and dyspnea had gradually progressed. There had been no orthopnea or edema of the ankles.

The patient stated that she had pertussis as a child and that in 1920 she had pleurisy which kept her in bed for several weeks. Otherwise, she had been perfectly well.

She was a well developed woman, lying comfortably in bed, with no respiratory distress. Paroxysms of coughing, dry and nonproductive, were evident but occasional. Her trachea was in the midline. There was hyperresonance over the entire right side of the chest, and posteriorly cavernous breath sounds and egophony could be heard. There was impaired fremitus over the entire right side of the chest. The left side of the chest was normal.

The rest of the physical examination was essentially noncontributory. There was no clubbing of the fingers and no cyanosis. Her blood pressure was normal. During her stay in the hospital, she had a low grade fever, the temperature spiking to between 99.2 and 99.3 daily. Her blood count and urine were normal on her admission to the hospital. Studies for acid-fast rods gave repeatedly negative results. The sedimentation rate and electrocardiograms were within normal limits. Thoracentesis was done shortly after her admission to the hospital, and intracystic pressures of plus 2 to plus 8 were found. This pressure was maintained after removal of 250 to 300 cc. of air. The patient experienced no respiratory distress during the procedure.

DR. CHAMBERLAIN: I think, Dr. Rosemond, that we ought to demonstrate some of our findings at this point. I am leaving J. T.'s roentgenograms on the illuminator because we will go back to them later. Our first examination of E. N. (fig. 2 *A*) showed a combination of factors, a pneumothorax and a large bleb or "balloon cyst" of the right lung. Now, it is with some temerity that I say that a pneumothorax and a bleb are present, because we observed cases right here in this Conference in which there appeared to be a pneumothorax but in which it turned out that there was a bleb, and we have certainly no right to insist that this case is

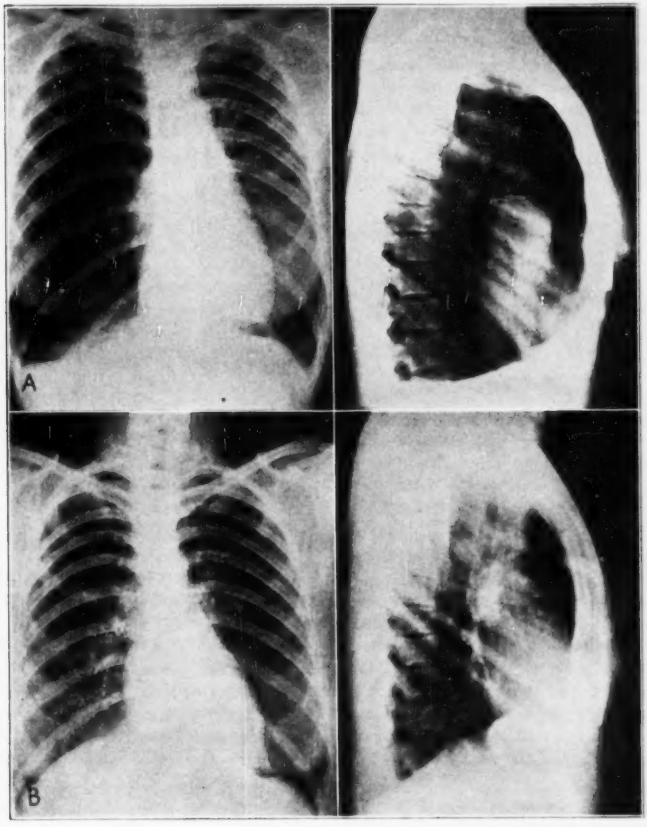


Fig. 2 (case 2, E. N.).—*A*, Aug. 8, 1944. Large "balloon cyst" accompanied with a recurring or persisting pneumothorax. The thin wall of the "cyst" can be traced where it is seen in profile. The right lung is completely collapsed and lies at and slightly ventrad of the right hilus. A mild degree of mediastinal herniation is visualized just ventral to the heart and aorta. *B*, Oct. 22, 1947, a little over three years after surgical extirpation of the "balloon cyst." From the standpoint of the roentgen appearance the only abnormality is the persistence of mild, generalized emphysema and a few "blebs."

not similar. However, the lung-shaped cyst seems to be divided off all the way around from the rest of the space. I think that this is pneumothorax outside of a large bleb. Such a combination is not infrequent, but it is not met with as often as the uncomplicated bullous emphysema.

We see here an element that has not been demonstrated in this other case and that is mediastinal herniation. I believe that you can see that in this air-filled space here (pointing to anterior mediastinum on lateral roentgenogram of August 8) either one of the blebs or the pneumothorax has gone through in front of the heart to produce this black outline which is characteristic of mediastinal hernia.

DR. BURNETT: Dr. Cohen determined these intracystic or intrapneumatocele pressures. It is his patient. Would you care to discuss these, Dr. Cohen?

DR. COHEN: Very little, except to add more to this history. The patient was dyspneic when I first saw her. In fact, she was extremely dyspneic on exertion. That was her presenting symptom. She was cyanotic, too. The case was referred as one of pneumothorax.

DR. CHAMBERLAIN: Was study of the respiratory physiology done before operation?

DR. COHEN: No.

DR. CHAMBERLAIN: The case occurred before we were doing that routinely.

Dr. Burnett, will you tell us about the operation?

DR. BURNETT: In some of these cases, as probably happened in this one, a valvular mechanism develops which balloons the involved area of the lung into greater and greater size. In this instance, because of the obvious deflation and displacement of the lung, the members of the Conference felt that the patient should be operated on, and she was subjected to operation. We found at the time that there was a small amount of pneumothorax and a large pneumatocele, with multiple smaller ones in the vicinity. All of them, however, were from the apex of the upper lobe, with rather small attachment. It required little dissection to remove the bullous areas and to conserve the upper lobe; so lobectomy was not required. It was easy to withdraw the bulla from the mediastinal herniation. There was no adherence there.

Then, all the bronchial openings having been repaired under positive pressure, the lung was seen to expand to about two thirds of its normal size. It subsequently came out completely with constant suction postoperatively. At first we could not expand it completely, although in some of the other cases complete expansion could be obtained immediately. We have had a recent roentgenogram on this patient, approximately three and a half years after operation. She has had no shortness of breath, cough or other respiratory symptoms and has returned to work. On physical examination, one finds that the wound has healed well, that the chest is resonant throughout—normal resonance and not hyperresonance—that the breath sounds are normally heard and that the diaphragm is moving on both sides. Will you demonstrate the follow-up roentgenogram?

DR. CHAMBERLAIN: Yes. The most recent roentgenograms are surprising—three years and two months after operation (fig. 2 *B*). The roentgen appearance speaks for itself. It is extraordinarily normal. Apparently the surgeons sneak these things out without doing even a rib resection. I cannot find the expected evidence of thoracic surgery here, Dr. Burnett. Do you not take the ribs out any more?

DR. BURNETT: Sometimes we do, but in this instance we did an inframammary incision, i.e., went through the third interspace anteriorly as we usually do for pneumonectomy or upper lobectomy. No deformity resulted.

Dr. Peale has the pathologic report, if he will be kind enough to give it to us.

DR. PEALE: The specimen as we received it was a cystic structure which, when opened, measured 20 cm. in diameter. The outer surface was relatively smooth. The inner surface was trabeculated. Accompanying this cyst was an irregular fragment of additional tissue.

This microscopic section is through the contiguous pulmonary tissue. I think you can see these areas where alveolar walls have broken down and coalesced and formed cystlike spaces. Then, here and there we see the terminal bronchial branches standing out as thick-walled structures which are penetrated by a few inflammatory cells. Then, in the areas spreading out from these bronchial walls we see that the contiguous alveolar walls are similarly thickened, so that we have here a picture of bullous emphysema, bronchiectasis and some interstitial pneumonitis. Whether the bronchiectasis and the interstitial pneumonitis are responsible for the bullous emphysema or not, I do not know. I notice that you used the term "pneumatocele." I wonder whether it was justified. I have checked several textbooks to see if it is mentioned, and I cannot find it. I looked it up in the medical dictionary, and pneumatocele is defined as air in the scrotum. I wonder if you are justified in using that term.

DR. BURNETT: The dictionary also states that it is "a tumor or sac containing gas" or may refer to "a hernial protrusion of the lung tissue." I believe it is used for blebs or bullae more commonly than for scrotal gas.

DR. CHAMBERLAIN: Pathologists are bound to get us into trouble somewhere along the line. Dr. Peale, what of the element of infection here? I was a little surprised to hear of the interstitial pneumonitis, because I thought that this was one case in which the element of infection was absent.

DR. PEALE: It looks chronic. How important it is at the present time, I do not know. It looked like a chronic affair of long standing because of the marked fibrosis and the lymphocytic infiltration.

DR. BURNETT: Shall we consider H. S.?

DR. CHAMBERLAIN: I think we should, because this dramatic, excellent result is not the whole story. We still want to know what happens in cases in which the process is diffuse. Will you introduce the case of H. S. for us, Dr. Rosemond?

DR. ROSEMOND: A 55 year old Negro was admitted to the hospital with a two and a half year history of frequent colds, chronic cough and increasing and incapacitating dyspnea. He had no orthopnea and no edema of the ankles. He was perfectly well until the onset of these symptoms. On physical examination, no cardiac murmurs were heard, and the rate and rhythm were normal. There was no demonstrable cardiac enlargement. There was hyperresonance over the right apex anteriorly and posteriorly, with diminished vocal fremitus in this same region. Numerous coarse rales and wheezes were heard over both pulmonary fields. There were rather notable clubbing of the fingers and cyanosis of the finger tips.

On the patient's admission to the hospital the urine was normal. A complete blood count showed a moderate degree of polycythemia. Allergic studies showed nothing significant. Intrathoracic pressure readings were taken at the time of air aspiration, and readings on the manometer of minus 5 plus 7 were obtained throughout the removal of 600 cc. of air, the readings being taken after each 100 cc. of air was removed. The patient showed no reaction to this maneuver. However, after the completion of the thoracentesis he experienced a moderate degree of dyspnea at rest, which soon passed away.

Dr. Durant and Dr. Roesler also saw this patient. Dr. Durant has a report.

DR. DURANT: Examination at that time showed cyanosis and clubbing of fingers but no dyspnea or orthopnea. The trachea was slightly to the right. The heart was normal on examination. There were sibilant rales throughout both pulmonary fields. The upper lobe of the right lung was less resonant than that of the left. Breath sounds were diminished over the former, and no coin sounds were noted as in cases of large pneumothorax.

The remainder of the examination was entirely noncontributory. It was my impression that surgical intervention was indicated in view of the crowding of the middle and lower lobes of the right lung, as visualized by the use of "lipiodol," and I stated that it would be of interest to know what the intracystic pressure was.

DR. BURNETT: Minus 5, plus 7.

DR. CHAMBERLAIN: The roentgen appearance, when we first saw this patient on Nov. 28, 1944, was rather characteristic of a widespread type of bullous emphysema in which the greatest involvement was in the upper portion of the right lung (fig. 3 *A*). An interesting finding which is often seen in such cases is the caudal displacement of the hilus. You will notice that the right hilus is displaced caudad because of the large balloon cyst or emphysematous bleb or collection of blebs at the right upper portion of the pulmonary space. The lateral view shows a tracery of fine lines, which are the septums between these blebs, and the term "vanishing lung," which one hears in connection with these cases, is brought to mind by this appearance. We see where the lung is compressed in part by the expansion of the balloon cysts or blebs. The condition is pretty widespread, and this case is reminiscent of the case of J. T. that we are now considering for decision.

The bronchographic study is shown here (fig. 3 *B*), and the element of bronchiectasis is not at all profound. In fact, the compression of the lung and the displacements are the big features of the case. If there is any bronchiectasis present, it is of the fusiform variety. Some of these bronchi look lobulated and increased in diameter, but they are all shortened by collapse, and shortened bronchi often look a bit irregular and thickened. There is abnormal density lined up with an area that does not show anything. So there may be something hidden from us. Certainly, bronchiectasis is not the outstanding feature, but it is rather the blebs or the bullous emphysema that dominate.

Were functional tests done in this case?

DR. BURNETT: Not in this one.

DR. CHAMBERLAIN: This was earlier than our studies of pulmonary physiology. On December 12, that is, a few days after the "lipiodol" study, pneumothorax was present, but I suppose that was produced by the needling for the determination of intracystic pressure. There is a pneumothorax here which had not been seen a few days earlier. Then, I believe it was shortly after that that you removed some of the blebs.

DR. BURNETT: Dr. Norris, bronchoscopic examination in this case was noncontributory, was it not?

DR. NORRIS: I am not sure.

DR. BURNETT: The members of the Conference decided that the patient should be subjected to operation, although, in looking back, we all wonder whether this additional amount of fibrosis and the extensive character of it make it worth while. Certainly, there was a great displacement of these big ballooned-out cavities which Dr. Chamberlain called to your attention. We did operate on him shortly after

these studies which have been demonstrated. There was a considerable degree of emphysema of the entire right lung, ranging from small dilated vesicles to large bullae, the largest of which measured about 8 by 10 cm. The majority were in the apex of the upper lobe and involved about a third of this lobe. There was another large bulla, making a thin-walled balloon measuring about 7 by 5 cm., of the middle lobe, and this was removed first. The remaining part of the lung contained small emphysematous blebs visible rather generally.

There was considerable pigmentation of the lungs, and in the apical portion there were little calcified nodules, suggesting old tuberculosis. There were multiple adhesions around the apex and a few posteriorly, but they were soft and old and easily separated. The anatomy otherwise was normal.

The follow-up study of this man covers a little over three years. He states that his shortness of breath is much more notable than it was before the operation. We heard from him once before and felt that he had improved slightly but not dramatically by any means. Now, he is retrogressing. He has been unable to hold a job for any long period; he worked about two weeks and then had to rest for two or three weeks because of his physical condition, and in the past year he has not worked at all.

The physical examination showed an emphysematous chest over which the breath sounds were barely audible, and he pulls his larynx down about an inch (2.5 cm.) each time he inspires. He has chronic cough and whitish sputum, and this has persisted since before the operation.

Dr. Oppenheimer has the results of a study of pulmonary function done on this patient as a follow-up procedure, though we did not have such a study before operation. Will you give us the data, Dr. Oppenheimer?

DR. OPPENHEIMER: I think that it will not be necessary to read the detailed figures, but I believe the summary is important, especially for the bronchospirometric study, which demonstrates conclusively that now the right lung is providing 72 per cent of the total oxygen consumption and functions with more than twice the efficiency of the left. The ventilatory capacity of the two lungs is about equal.

DR. CHAMBERLAIN: It was the right lung, Dr. Burnett, which you worked on. That is reassuring.

DR. BURNETT: We realize that this is a progressive malady, and, unless we can remove the cause, the question is whether the palliation which we can offer is of sufficient value to the patients. That is what I wanted the Conference to consider today. Apparently, this man might have been a good deal worse off had he not had the surgical treatment, since in some of the few severe cases we have been unable to deal with the condition at all and have seen the patients choke to death gradually from progression of disease.

DR. CHAMBERLAIN: I am particularly interested in those spirometric studies because it is seen that the roentgenologic appearance has improved tremendously as a result of the operation (fig. 3*C*). I was a little disappointed to hear that the man is not able to work steadily and that he has great respiratory difficulty, because certainly the drooping of the right hilus and the compression of the right lung by the large air-filled spaces that were present before the operation have disappeared entirely, and a good appearance is seen in the roentgenograms made a few days ago at the time of the spirometric study.

DR. BURNETT: This man's disease might have progressed much more rapidly had he not had the increased capacity which was given by surgical intervention.

DR. CHAMBERLAIN: Was there anything significant in the surgical specimens in the case of H. S., Dr. Peale?

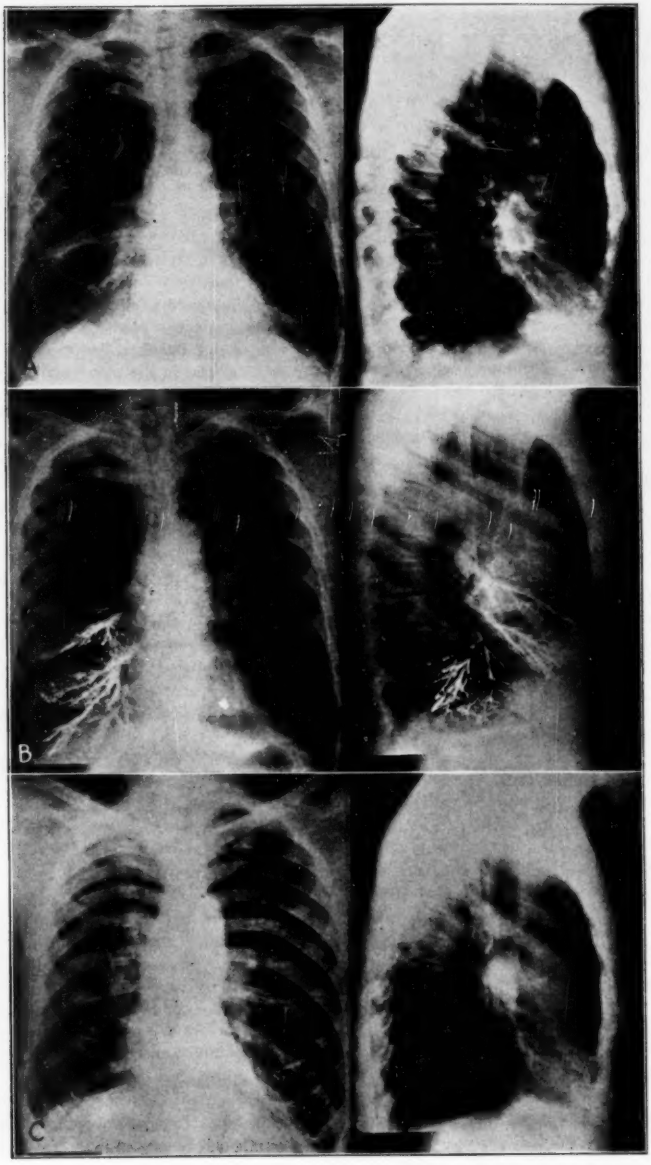


Figure 3

*See legend on opposite page*

DR. PEALE: No. Your point on the bronchiectasis is true; we found nothing. The only comment I should like to make is that there was tremendous scarring.

DR. CHAMBERLAIN: Fibrosis of the lung?

DR. PEALE: Yes.

DR. CHAMBERLAIN: Was it a diffuse interstitial fibrosis?

DR. PEALE: Yes, it was. Of course, we saw it only in one section.

DR. CHAMBERLAIN: We call it nonspecific because we see it in all sorts of conditions. Dr. Burnett, I think, feels that it may have been a factor in the difficulty which the man is now having, and I should think so, because many patients, without having had emphysematous blebs and without having undergone an operation, are really functionally disturbed to a pronounced degree by pulmonary fibrosis. That was found in the operative specimen and is obvious on the original and on the present roentgenograms, but mechanically it looks as though a great improvement had been made in the right lung by the surgical treatment.

Yet, according to the studies of respiratory physiology, the left lung is much worse off than the right, and in the left we have nothing to remove surgically. We have a problem. Do you think it might be advisable, Dr. Burnett, in view of the fact that he is doing so well with his right lung, to bring this man back for "lipiodol" bronchographic study and mapping of his left side? He may have more bronchiectasis on the left than we realize, and we might even find that we could benefit him further by treating it if it is present.

DR. BURNETT: That is possible. I should think, though, that it would be most unwise to remove any pulmonary structure as long as he does not show any gross degree of infection and the sputum does not indicate it at present, although we have not had a culture. What we have been considering since we had this follow-up report is whether or not autonomic denervation might be of some value to him. He is a poor risk for any surgical treatment in his present state.

DR. CHAMBERLAIN: Is he asthmatic?

DR. BURNETT: He seems to be extremely uncomfortable; even when he is sitting still, he leans forward to breathe, and he is using accessory muscles all the time to a mild degree. He is not at all a good risk, and I am sure that we can offer him little.

DR. GINSBURG: May I ask whether there is much of a bronchospastic element now?

DR. BURNETT: We do not hear whistling or wheezing at present, Dr. Ginsburg. He has no spasmodic attacks.

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Fig. 3 (case 3, H. S.).—*A*, Nov. 28, 1944. Collection of large blebs in the region of the upper lobe of the right lung, displacing the lung, including the hilus. Note also the evidence of a large number of small blebs, diffusely distributed throughout the right lung. *B*, Dec. 6, 1944. "Lipiodol" bronchograms. Some of the bronchi appear widened, but there is no evidence of sacular bronchiectasis. The principal finding is the compression of the lung and the displacement of the bronchi. *C*, Oct. 21, 1947. Follow-up roentgenograms taken approximately three years after surgical extirpation of the large blebs in the upper and middle lobes of right lung. At the time of this follow-up visit studies of respiratory function, including bronchospirometric study, showed the right lung to be functioning twice as efficiently as the left. Yet the roentgenologic findings indicate persistence of the many small blebs diffusely distributed throughout the right lung, with the left pulmonary field comparatively normal in appearance. The impaired function of the left lung may be due to fibrosis (note prominent markings), bronchiectasis (note abnormal density at left base) and emphysema (note caudal displacement of left leaf of diaphragm).

DR. GINSBURG: Is there any indication from the roentgenograms that the left lung might have less function than the right?

DR. CHAMBERLAIN: Not at all. I am as surprised as anybody in the Conference to hear the bronchospirometric data. It is the second case in succession in which the roentgen findings did not give an indication of the relative function of the two lungs.

DR. OPPENHEIMER: Dr. Chamberlain, does this illustrate Max Pinner's point that if the pleura is not extensively involved one can have good pulmonary function, even though the roentgenographic appearance of the parenchyma is bad?

DR. CHAMBERLAIN: Well, perhaps it does.

DR. COHEN: He has pleurisy at the left base, which would fit in with the poor function of his left lung.

DR. CHAMBERLAIN: Yes, but does it really fit in? Does the pleurisy of the base only interfere with the function? It is really the pleura around the outside of the lung—the rind on the orange—that counts, is it not?

DR. COHEN: In pulmonary tuberculosis the practical application of pulmonary functional study is to demonstrate that the contralateral lung, which looks healthy on roentgenologic study, really does have good function. We sometimes obtain data showing poor function in this lung.

DR. GINSBURG: Do you think that there might be any indication that there is a shift to the right in the cardiac silhouette in the interim between roentgenologic studies?

DR. CHAMBERLAIN: We can easily tell that by putting the original roentgenogram next to the most recent one (fig. 3 *C*), because in both cases the centering is good. The medial ends of the clavicles are matched with the spinous processes, and I think we can say that the heart is a little to the right now as compared with the former position.

DR. GINSBURG: Dr. Burnett, are you surprised that in these cases we have not found any bronchiolar stenosis as a cause for the pulmonary changes?

DR. CHAMBERLAIN: In other words, the pathologist has not described a bronchiolar stenosis in these cases.

DR. BURNETT: The pathologist has not had an opportunity to see that really, because all we have removed from these patients so far has been extrabronchial material, simply the broken-down alveoli or the subpleural bleb. So we cannot say that there is no bronchial stenosis. We have seen bronchial openings, naturally, and have tried to occlude them, but we have not removed pieces of bronchus or bronchioles for the pathologist to see.

DR. GINSBURG: I mention this because of Dr. Amberson's demonstration. I wondered if we had been able to show anything significant in these cases.

DR. CHAMBERLAIN: Dr. Rosemond, will you introduce for us the case of L. M.?

DR. ROSEMOND: L. M., a 51 year old white woman, was admitted to the hospital with a history of having been perfectly well until seven months before. While riding in an airplane, she experienced a sudden sharp pain in the left side of the chest, followed by rather pronounced dyspnea. The dyspnea continued for a short while after she returned to the ground and then cleared completely. Since that time, she has had several similar experiences, without flying, recurring as often as every two or three weeks. She has had sharp pain in her chest followed by dyspnea with all these attacks. She has been under treatment for this by her local physician. There has been no edema of the ankles.

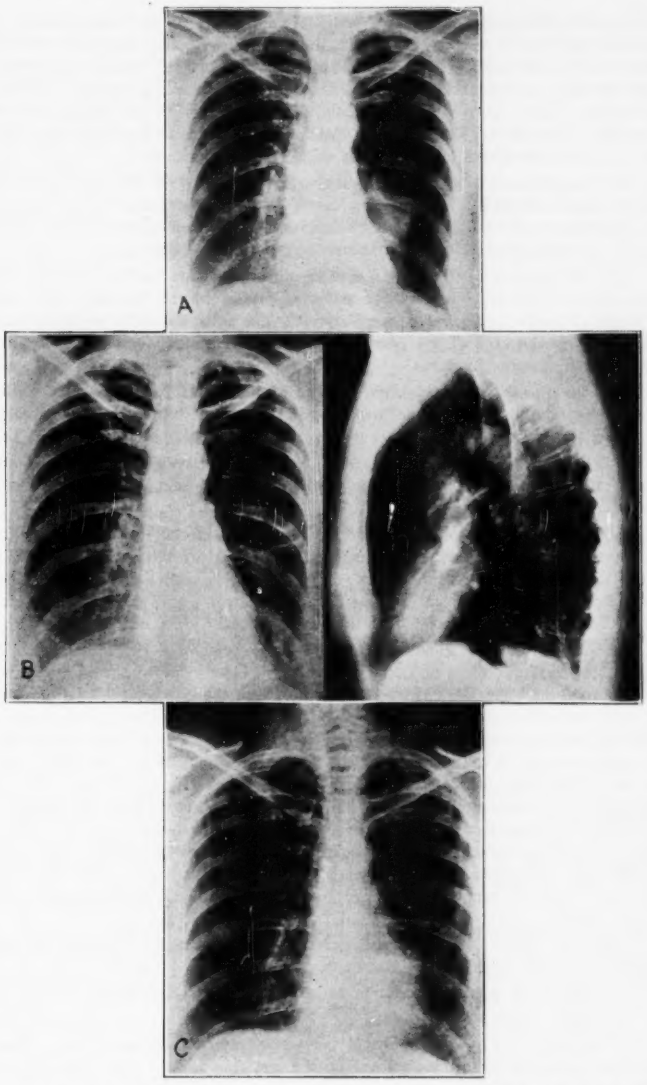


Fig. 4 (case 4, L. McN.).—*A*, Oct. 11, 1946. Massive spontaneous pneumothorax on the left, incurred in the course of an airplane flight. *B*, Feb. 7, 1947. Pneumothorax still present but with sufficient reexpansion of left lung to show the presence of bullous emphysema. *C*, Oct. 7, 1947. Ventral projection approximately eight months after surgical extirpation of blebs. The roentgenologic appearance is essentially normal.

Physical examination revealed a well developed 51 year old white woman in moderate respiratory distress while lying in bed. The heart sounds were distant. There were no murmurs. The rate and rhythm were normal. There was bilateral hyperresonance, more marked on the left side. There was a suggestion of a lag on the left. There were no rales, and the breath sounds over the left side of the chest were diminished. There was no clubbing or cyanosis of the finger tips. On her admission, the blood count and the urine were normal.

DR. CHAMBERLAIN: The original studies, in October 1946 (fig. 4 *A*) showed just the pneumothorax with the compressed left lung and some displacement of the mediastinum toward the right. There was no evident disease on the right except for some congestion and prominence of pulmonary vessels.

Then, in February 1947 (fig. 4 *B*), as the lung expanded with the gradual disappearance of the pneumothorax, fine lines showed up in the lung that are, of course, characteristic of bullous emphysema. The outlining of the aorta coursing along through the area of the pneumothorax is interesting. One does not often get an aortic shadow like that.

The next roentgenograms which I have after February 7 were taken after surgical intervention, so I think that we had better ask for further information regarding this case.

DR. BURNETT: Dr. Oppenheimer, will you give the results of the functional studies at the time in February when there was partial reexpansion of the lung after the pneumothorax?

DR. OPPENHEIMER: We have only the results of external spirometric studies, Dr. Burnett. The efficiency of respiration as measured by the ventilation equivalent is normal, but the reserve capacity is well below normal limits as determined according to a series that Dr. Burnett has collected for us. The reserve capacity is only 72 per cent. We feel that it should be at least 75 per cent or above.

DR. BURNETT: This illustrated to us another type of event associated with these emphysematous blebs or bullae, in which repeated rupture occurs and pneumothorax results. As Dr. Chamberlain pointed out, the only cystic area of much size was not a large one, possibly 5 by 7 cm. at the most, although there were others of smaller size in that vicinity. But the patient had these repeated episodes of pneumothorax; so the members of the Conference felt that she should be operated on. She was subjected to surgical treatment and this small cyst removed. Incidentally, it was found to have a few adhesions which apparently helped to break it open, or to tear it open. They were rather strong ones, three of them, leading up to the thoracic wall and under tension when we opened the chest. So possibly they contributed to this repeated rupture, although we admit that they could have resulted from the original rupture. After removal, the lung reexpanded rather readily.

There was a middle lobe also on this left side, indicating a congenital anomaly possibly associated with this formation.

DR. HUBER: It is rather common to have an extra fissure there, so I would not attach any significance to it.

DR. CHAMBERLAIN: I knew Dr. Huber would say that, because he has shown us a great many of these middle lobes on the left side.

DR. BURNETT: We have seen a few of them at operation also but not enough to think it is common.

DR. HUBER: There is some representation of a fissure in close to 50 per cent of cases—some indication of representation of the fissure between the superior and the inferior division.

DR. BURNETT: We have a follow-up report on this patient covering a period of about six months (fig. 4 *C*). She had gained somewhat in weight, about 3 pounds (1.3 Kg.). She complained only of weakness. She looks well and is able to walk upstairs without breathlessness and to conduct all her normal activities in comfortable fashion. Pneumothorax has not recurred.

The physical examination showed a well healed inframammary scar. There is no evidence of collapse of the left lung; it seems well expanded, and breath sounds are heard, although softly, throughout the left side of the chest. There is no lag. There is good expansion on both sides. Percussion is clear throughout. Her general appearance is good, and we consider the result exceedingly satisfactory.

DR. CHAMBERLAIN: Some of us like to fly, and we are interested in the fact that pneumothorax developed in this woman as a result of an airplane trip. If she had a blocked air-containing space, an emphysematous bleb that temporarily had no orifice, it might have something to do with the rupture because air-filled spaces certainly do enlarge remarkably during increase of altitude. A bowel with some gas in it, for instance, can cause acute pain. I have seen army fliers in the artificial altitude chamber experience severe pain in the abdomen as a result of having some gas in the colon. It is amazing what will happen to gas-containing spaces at high altitude. Ordinarily, a space that connects freely with the bronchial system should not be under any strain as a result of altitude.

DR. PEALE: There was nothing significant found in the pathologic examination except that the walls in some of these cysts were thick and mucilaginous, with patchy areas of calcification.

DR. CHAMBERLAIN: That is interesting. We do not see any evidence of patchy areas of calcification in our roentgenogram.

DR. PEALE: Microscopic.

DR. CHAMBERLAIN: The outcome in this case is extremely good, indeed. Now I should like to call for the report on Mr. F. S., from whose case we learned so much about the condition of bullous emphysema.

DR. BURNETT: Dr. Chamberlain, may I add one thing? I cannot find the record of it here, but there was a follow-up external spirometric study of Mrs. L. M. which showed a 74 per cent reserve capacity, and the note was made by the examiner who did this particular test that the patient was excited and not actually in a basal state so that her reserve is probably higher than 74 per cent. At least it is two points higher than it was before she was operated on, and clinically she seems a great deal better, which suggests that the observation was correct that there was more spread between basal and forced breathing than was put on the report.

DR. CHAMBERLAIN: As we are now considering bullous emphysema or emphysematous blebs, I should like to have a review of the case of F. S. Dr. Rosemond will introduce this case, brought to us by Dr. Cohen before we knew much about the condition.

DR. ROSEMOND: F. S., a 30 year old white man, was admitted to the hospital with a history of increasing dyspnea on exertion for three years, until it was incapacitating, and of an increasing amount of chronic cough which recently had become productive. The cough was accompanied with pain in the right side of the chest. There was no hemoptysis or night sweats and no known tuberculous contact. Six months prior to admission, he had a bilateral Caldwell-Luc operation, with some alleviation of his cough.

His personal history was noncontributory in relation to the present illness. Physical examination revealed a fairly well developed white man who was in no great degree of respiratory embarrassment while lying in bed. There was hyperresonance over the entire right side of the chest and anteriorly over the mediastinum. The remainder of the pulmonary fields was normal. Over the tympanitic area vocal fremitus was decreased and breath sounds were absent.

There was no clubbing or cyanosis of the finger tips and no edema of the ankles. Numerous readings within the cyst cavity showed an initial pressure of plus 2 to

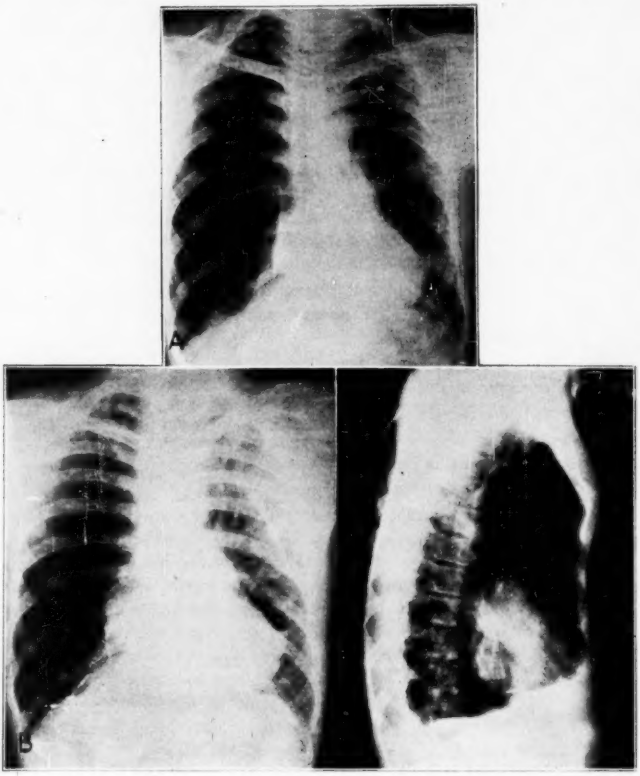

Fig. 5 (case 5, F. S.).—*A*, Jan. 19, 1943. A most remarkable case of balloon cysts (bullous emphysema) in which the compressed and almost airless right lung is seen in the region normally occupied by the vena cava. *B*, Jan. 21, 1943. "Lipiodol" introduced through a thoracentesis needle has accentuated the veil-like, membranous septums which divide the various blebs from each other. Note the pronounced mediastinal herniation, with mediastinal layers of pleura displaced far over toward the left axilla.

minus 4, and on deep inspiration this was reduced to zero minus 14. Then 250 cc. of air was removed, with the resulting pressures: normal breathing, plus 2 minus 6; deep inspiration, zero minus 20.

The blood count and the urine were normal and repeated examinations of the sputum revealed no acid-fast rods. The urine was also examined for evidence of acid-fast rods, and they were not found. Examination of the heart, including electrocardiographic study, showed it to be normal.

DR. CHAMBERLAIN: At the first examination (demonstrating roentgenograms) we see an almost complete absence of detail in the right pulmonary field, which led us to a diagnosis of pneumothorax. Note this "ballooning" over through the anterior mediastinum toward the left side (fig. 5). The left border of this structure, which turned out to be a huge balloon cyst, is over against the left ribs (fig. 5 *A*).

After Dr. Cohen had carried out considerable aspiration, to decompress this from positive pressure to negative pressure, we finally got this margin of one of the large cysts to move over so that it can be seen in the left pulmonary field (fig. 5 *B*). It is over against the left rib cage in the first study.

The January 1943 planigraphic studies showed some lung down in the region of the cardiohepatic angle at the right base, with the layers of mediastinal pleura close to the left axillary ribs. I think this is a rather dramatic demonstration of mediastinal herniation. This is part of one of the big cysts of the right lung over in the left side of the thorax through the mediastinal hernia.

Now, I should like to hear from Dr. Cohen regarding his interesting findings in relation to the pneumothorax pressure readings.

DR. COHEN: This patient came into the office, or was brought into the office, in critical condition because of dyspnea, cyanosis and pain in the right side of the chest. He had roentgenograms with him, taken eighteen months previously, showing almost the same condition. There was a complete absence of lung in the right side of the thorax. It looked like an ordinary spontaneous pneumothorax, and I thought it was and immediately carried out aspiration for decompression. I was greatly surprised when, after great quantities of air, probably 2,000 cc. had been taken out, the patient felt worse and was just the reverse of what we expect after aspiration for spontaneous pneumothorax. In fact, he experienced such great pain that I was alarmed.

One of the interesting factors was that the patient was so sick that after study in the Chest Conference and aspiration of air and preparation for possible surgical intervention, it was questionable whether he could stand surgical procedure. I thought he could not and Dr. Long, who was interested in studies of pulmonary function, persuaded him to have the operation. He slept sitting on a chair with his head on the bed. That is how dyspneic he was.

We introduced some "lipiodol" into the cavity, which gave us further evidence of the presence of a cyst.

DR. CHAMBERLAIN: Dr. Burnett, will you tell us about the operative findings in this case?

DR. BURNETT: Yes. Major difficulty was experienced in putting this patient under anesthesia, and he was so dyspneic that it was a problem. Our anesthetist, Dr. Woodbridge, had a great deal of difficulty. Although he slipped the intratracheal tube in rapidly, as usual, the patient became cyanotic before the tube was in deep enough to be used. We were frightened for a moment or two about his survival. After that, there was little difficulty. Apparently the readings of the intracystic pressure had produced pneumothorax, so we found a rather extensive one when we opened the chest and a small amount, 300 or 400 cc. of slightly turbid, grayish fluid. The lung was completely collapsed; the cyst was partly collapsed, and the mediastinal herniation was not so great as demonstrated on some of the

earlier roentgenograms. It measured 12 to 15 cm. from the caudal to the cephalic end and about 3 to 4 cm. anteroposteriorly. The bleb was a tremendous one with an extremely thin wall, so that the mere attempt to handle it tore it into small shreds and sheets and there was little to send to the laboratory, although we excised it completely. The herniation extended about 15 cm. across from the midline into the left side of the chest. There were no adhesions over there, and the extrusion was easily withdrawn.

An interesting fact was that there was a small pedicle, only 2 to 3 cm. in size, with two small vessels and one bronchial opening. It required actually one hemostat's length to encompass the whole area, after which the lung was expanded by gentle positive pressure and rapidly came to full expansion without any difficulty. It was normal in appearance in its other areas, except for one immediately adjacent small bulla about 2 cm. in diameter, which we took out. I do not believe that the needle was in that small one, which was rather inaccessible. I think it was in the large one, and the "lipiodol" which was inserted is shown along the trabeculae within the fibrous irregular wall of the broken-down alveoli.

DR. COHEN: The surprising thing to me, Dr. Chamberlain, was that we had roentgenograms which were taken eighteen months prior to this, and it was apparent that the condition was present all this time, with complete compression of the right lung, and still the lung was not carnified. It was healthy looking and expanded rather easily (fig. 6 *A*).

DR. CHAMBERLAIN: I think that is something which we can put down in the record to remember, because it indicates, does it not, that there can be a prolonged compression of a lung without the loss of its function or ability to reexpand, provided the element of infection is absent.

DR. COHEN: You mean complete compression?

DR. CHAMBERLAIN: Yes.

DR. BURNETT: If there is no fibrosis or bronchial blockage, it has been our experience that the lung will rapidly expand. We have a five year follow-up report on this patient, who was seen within the month. He states that he is greatly improved. He notices no abnormal breathlessness. In other words, he has normal breathing capacity as far as can be determined and has no complaint except that all the symptoms referable to the sinusitis for which he has been treated are still present.

Examination of his chest revealed no abnormality of the lungs or of the diaphragmatic movement, and his average weight is now 130 pounds (59 Kg.). It was 90 pounds (40.8 Kg.) previous to operation.

We have results of follow-up external, spirometric and bronchospirometric study, although such study was not made preoperatively. May we have data, Dr. Oppenheimer?

DR. OPPENHEIMER: For external spirometry, the efficiency of respiration is normal as shown by the low ventilation equivalent, which was 1.9, from 1 to 3 being normal. Maximum breathing capacity is low, being 16 liters, and for a man of his size the level ought to go up to 100 liters at any rate. The patient shows good ability to increase the depth of respiration above the resting level, which probably accounts for his lack of dyspnea on exertion. He had a vital capacity of 2,000 cc.

Bronchospirometric study indicates a normal distribution of oxygen consumption between the two lungs. The right lung functions more efficiently than the left. The ventilation equivalent on the right is 1.4 and on the left 4.0; however, the left lung has greater capacity for ventilation, providing 60 per cent of the maximum breathing capacity.

DR. CHAMBERLAIN: That is interesting indeed.

I just want to point to the most recent roentgenograms, taken a few days ago for follow-up study (fig. 6 *B*). They show a good pair of lungs and are in keeping with what you have just heard. One can find a couple of thin lines at the right apex, suggesting that there might be one or two little emphysematous blebs up there where the excision was done but nothing important and nothing to interfere with pulmonary function.

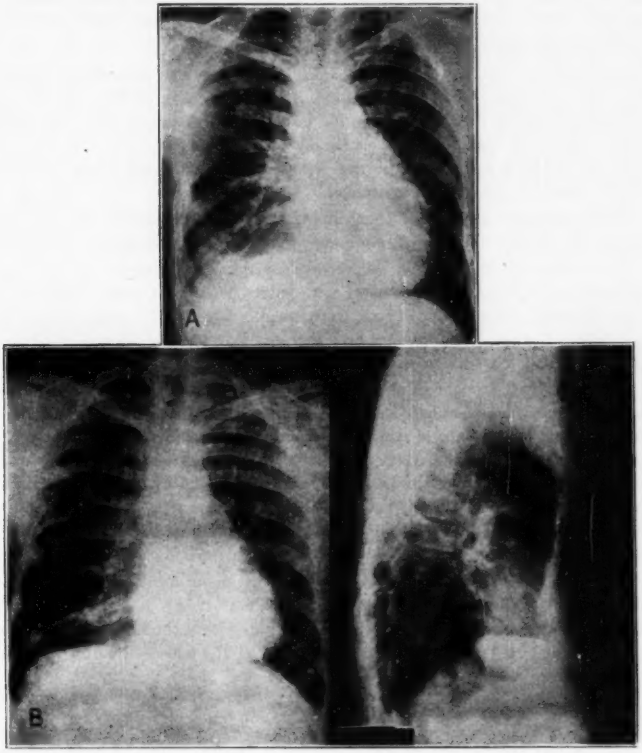


Fig. 6 (case 5, F. S.).—*A*, March 4, 1943. Appearance three weeks after surgical extirpation of large balloon cysts by division of the "pedicle" by which they were attached to the apex of the right lung. Reexpansion of the long-compressed right lung was prompt, being accomplished under observation during the operation. *B*, Oct. 20, 1947. Follow-up roentgenograms taken four and a half years after surgical removal of balloon cysts. Except for unimportant scars of the right lung and the rib cage, the roentgen appearance is normal. The patient is clinically well.

About the only abnormality that is obvious is the fact that the surgeon has operated on that area. There is a rib scar in this particular case because of the different kind of incision.

I think we now ought to consider J. T. again. We have reviewed the other cases, and I should like to get the Conference to express an opinion with regard to the current case that is up for decision. Personally, Dr. Burnett, I should like to go on record as not being in favor of surgical intervention in the case of J. T., on the ground that the disease is widespread throughout the lung and is not concentrated in any particular area to the point where we would expect you to accomplish much. However, you might improve the situation somewhat if you could take out anything that occupies as much space as the bleb here, the bleb there and this bleb in the region of the middle lobe shown in the lateral views (pointing to figure 1). This last may not be in the middle lobe at all; it may be in the left lung.

Dr. Cohen, what is your opinion in regard to therapy?

DR. COHEN: We had a patient named A. L. who had something similar to this, not so circumscribed but generalized. I do not believe he did so well. I am a little bit afraid of surgical intervention in this case, especially with a pulmonary reserve of 38 per cent. It is an extremely low reserve. So I do not think you would get a good result in this case with surgical treatment unless you could remove some infection or bronchiectasis.

DR. CHAMBERLAIN: Dr. Oppenheimer, would you be willing to express an opinion on whether this patient could undergo surgical treatment?

DR. OPPENHEIMER: While the reserve is low, Dr. Burnett has continually astounded us by operating on patients with values below that which we have considered normal. As a matter of fact, we frequently have had to reduce the minimal level which is considered safe because the surgeons have continued to show us that one could go below the published figures. This is low, however.

DR. BURNETT: I might mention the fact that there have been 7 additional cases of this type in which operation has been performed, with five good results, one fair result and one poor result, of which Dr. Cohen spoke a moment ago (Mr. A. L.). Incidentally, Mr. A. L. was reoperated on because of what appeared to be a persisting cyst, but it proved to be an organized hemothorax overlying an endothelioma of the pleura. Those are the reasons for persistent trouble. That was about a year after his original operation. He is still in the hospital after his second exploration and is receiving roentgen ray therapy for his malignant tumor.

I think we can help those patients who have a large but localized area of involvement, but this patient does not seem to be of that type. It seems to me that probably the three small areas shown on the right, with more function on the right than on the left as shown by bronchospirometric study, are not interfering greatly with his health. None of those areas measured over about 10 by 6 cm.

DR. CHAMBERLAIN: Something like that.

DR. BURNETT: That is the largest one, and there are three visible on one side or the other as well as generalized small ones. He has improved a good deal on the present conservative therapy, and I think it might be well to persist in this.

The thing that appealed to me most about operating on this man was the possibility of denervation and consequent decrease in the bronchospasm, which is probably the cause of most of the trouble. Although he has not had a history of asthma, he did respond at first to bronchial dilators, and most of the studies that have been made on these patients have demonstrated bronchospasm in some degree. I think that if we ever decide to operate on him, the decision would probably have as its basic motive the desire to denervate the lungs rather than to excise the cysts. I would agree with the more conservative view. What do you think, Dr. Rosemond?

DR. ROSEMOND: The patient has improved. I think we should withhold surgical treatment. I was also thinking of the possibility of denervation. I would be inclined to leave as much of the lung as possible in this patient. There might be some large, easily accessible cyst which could be easily removed, but I do not think that he would be able to stand extensive surgical procedure. I do think his condition ought to be reevaluated now because he has improved and the pulmonary function might be a great deal better at the present time than it was eight months ago.

DR. CHAMBERLAIN: Dr. Ginsburg, the department of internal medicine should express an opinion on this point.

DR. GINSBURG: Dr. Burnett has studied a number of these cases and has operated in some in which there was greatly reduced pulmonary function, with improvement in most instances. It appears that this patient has a decreased amount of sputum now and less bronchospasm, as evidenced by wheezing, probably because of the decreased infection in the pulmonary field. We often find that cough alone will cause spasm. If that has been reduced, the sputum decreased and the cough relieved, he may be improved for a long time without surgical intervention.

I think Dr. Rosemond suggested reevaluation now that the infection at least appears to have been controlled.

DR. WESTON: Will you tell us briefly what the denervation procedure is?

DR. BURNETT: Two have been recommended. Rienhoff has reported[1] several instances of denervation of the posterior pulmonary plexus, which includes vagus and sympathetic fibers. He reported 21 cases five years ago in which there had been considerable improvement in 3, moderate improvement in 5 and no improvement in 13.

More recently, Duane Carr,[2] at the meeting of the Association for Thoracic Surgery, suggested removal of the second, third, fourth and fifth thoracic sympathetic ganglions on each side through a small posterior incision, which is a much less extensive procedure than dissection of the pulmonary plexus in cases in which the volume is low. He was using it for treatment of asthma. Osler Abbott,[3] in discussion, said that he had applied the procedure in a few cases of pulmonary emphysema and thought it was worth while. This seems illogical from a physiologic viewpoint. Both maneuvers are of questionable value, but we are treating a disease which is frequently fatal.

To summarize, then, the cause of this condition is not well known, but both logic and the general opinion are behind the thought that there is definitely increased intrabronchiolar pressure which can be contributed to by bronchospasm, allergy and infection singly or together. That there is a check valve mechanism in many cases, causing extreme ballooning and the tremendous size which is sometimes seen, is undeniable. Certainly allergy can play a part and should be investigated in each instance.

Two items in the pathologic process should be stressed. One is that there is usually more extensive disease than can be demonstrated by roentgenologic study and the other that there is a progression of the disease unless the cause

1. Rienhoff, W. M., and Gay, L. N.: Further Observations on Treatment of Intractable Bronchial Asthma by Bilateral Resection of Pulmonary Plexus, J. Allergy **13**:626-631, 1942.

2. Carr, D.: Personal communication to the author.

3. Abbott, O. A.: Personal communication to the author.

can be found and abolished. This means that treatment usually is palliative rather than curative. Unless the cause can be abolished, there is a gradually increasing diminution in the ventilatory capacity and of absorptive surfaces so that anoxia develops and progresses until a horrible death by asphyxia occurs. Palliation can delay this end for variable periods. A severe degree of anoxia was noted in some of the patients discussed, and a few others for whom palliation could not be attempted because of the extreme degree of the pathologic changes have progressed to such a miserable ending.

It is understandable, therefore, that we are interested in doing all things which can delay or possibly arrest the process and consider even procedures which are not too well accepted. Ideally, the treatment should follow the usual principle of eliminating the cause and ridding the patient also of the pathologic changes caused by the etiologic factor while active. Neither of these is usually susceptible of complete accomplishment, but we should bend every effort toward elimination of infection, of bronchospasm and of allergy. This objective is best accomplished by inhalation of antibiotics of an appropriate nature, with wetting agents for more rapid penetration or at times bronchial relaxants such as epinephrine hydrochloride in the more extreme cases of bronchospasm. A thorough allergic study, with avoidance of allergens as indicated and desensitization as far as possible, is of considerable importance. These measures can lead to great improvement clinically and to partial or even complete arrest of the progression. Associated treatment of the congestive heart failure which often develops from the cor pulmonale may aid considerably.

Since palliation is usually of vital importance, surgical intervention has a definite but limited place. Certainly diffuse generalized break-down of alveolar structure, with the areas measuring from a few millimeters to 4 or 5 cm. in size, cannot be helped by excision, but may be delayed or arrested by neurectomy of the vagal influence or, paradoxically, by the more limited risk of sympathetic ganglionectomy as applied with some success by Carr and Abbott on the hypothesis that congestion of the mucous membrane and viscid secretion rather than bronchospasm may be causative and that interruption of the sympathetic nerves may decrease this feature.[2] These procedures, however, are of questionable value and are still under observation for their empiric effect.

When the greater part of the lesion is localized in a lobe or part of a lobe and is large, measuring 15 cm. or more, great benefit can result from excision, which permits reexpansion of collapsed functional respiratory tissue and thereby greatly improves the respiratory reserve. Several of the patients discussed had such localized lesions, which in two instances occupied the entire hemithorax and extended across the mediastinum to invade the opposite side. The remainder of the lungs in these instances showed little impairment, and tremendous advantage was obtained by excising the pedunculated ballooned cysts or bullae. The improvement justifies the risk of thoracotomy, and it is possible that a simpler method of deflating and eradicating the bullae can be developed.[4]

A few of the patients in this series have been clinically cured, several others have been greatly improved although there is still some disease and some functional impairment, and 2 have shown little or no improvement, although functional study reveals that the lung operated on is functioning better than

4. At the Quebec meeting of the American Association for Thoracic Surgery Dr. Jerome Head and his associates presented several cases in which patients were apparently cured of large and medium-sized bullae by the simple maneuver of prolonged intercavity drainage.

the opposite one since the operation was done. External spirometric and bronchospirometric study has been utilized in the more recent cases for more graphic demonstration of the results observed clinically, and the results correspond to the statements made. Low preoperative functional tests, if not too extreme, may indicate rather than contraindicate palliative surgical procedure, since function should be immediately improved by reexpanding the collapsed useful pulmonary tissue.

We have reserved lobectomy for those patients with truly intrapulmonary cysts of a congenital nature in which infection so frequently supervenes. In the cases in which bullae have been present it has not been necessary to do lobectomy but only excision of the area involved, conserving the remaining useful lung. In some instances several bullae were removed, in 1 case from all three of the lobes on the right.

The condition should be suspected in any case in which the presenting symptom is dyspnea, in which repeated episodes of spontaneous pneumothorax occur or in which emphysema is found on physical examination. Large bullae are often mistaken for pneumothorax even on roentgenologic study. Roentgenography is usually diagnostic, demonstrating rarified areas, "vanishing lung," fine trabeculations in the cavity and, in severe cases, compressed lung, displaced mediastinum, drooping of the hilus and even mediastinal herniation. Intracavitary pressure readings contribute no diagnostic aid and are frequently harmful. They often add the additional dysfunction of pneumothorax to the symptoms of an already distressd patient when the extremely thin wall is torn. I see no reason for their continued use.

The condition of the patient under consideration, then, will be reevaluated and presented to the Conference again at a future time for further consideration. He does not seem to be a good candidate for surgical intervention, since his disease is rather generalized and there are no localized huge dilated areas which could be excised.

DR. CHAMBERLAIN: Since it is late, there is insufficient time to take up other cases. The Conference is adjourned.

# PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

**A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons**

## XI. CONDITIONS INVOLVING THE LOWER PART OF THE BACK

**Prepared by**

**R. BEVERLY RANEY, M.D., DURHAM, N. C.**

*Introduction.*—In 1947 a discussion of ruptured intervertebral disks and sciatic pain was prefaced by Barr [414] with the following introduction: "As students of the defects and diseases of the human frame, we are daily reminded that the truth is hard to come by, and that our knowledge of any medical subject is incomplete, defective, and capable of continually being increased." I know of no statement which might be applied more pertinently to the 1946 literature on conditions involving the lower part of the back. Although these writings were voluminous, few original concepts or technics were introduced and little unanimity concerning pathogenesis or treatment was apparent. Accordingly, and for the sake of brevity, many articles have simply been cited in this review, while most of the more significant contributions have been briefly abstracted. References to several foreign articles published prior to 1946 but not previously available for abstracting have been included.

*Pain in the Lower Part of the Back.*—The importance of pain in the lower part of the back in the practice of medicine calls forth each year a number of articles discussing in more or less general terms its differential diagnosis and treatment. Papers of this type have been published by Bankart,[415] Rizzo,[416] Hudson,[417] Torrance,[418] Walter,[419] Stewart,[420] Lee,[421] and Larochelle.[422] A detailed routine for standard-

414. Barr, J. S.: Ruptured Intervertebral Disc and Sciatic Pain, J. Bone & Joint Surg. **29**:429-437 (April) 1947.

415. Bankart, A. S. B.: Low Back Pain and Sciatica, Practitioner **157**:367-371 (Nov.) 1946.

416. Rizzo, P. C.: Backache, Indust. Med. **15**:642-643 (Nov.) 1946.

417. Hudson, R. T.: Backache, Kentucky M. J. **43**:324-327 (Dec.) 1945.

418. Torrance, C. C.: Low Back Pain, Mississippi Valley M. J. **68**:112-116 (Oct.) 1946.

419. Walter, A. B.: Weak Back, Canad. M. A. J. **54**:252-255 (March) 1946.

420. Stewart, S. F.: Low Back Pain, Plantation Health (no. 2) **10**:12-14 (April) 1946.

izing the examination and diagnosis in cases of pain low in the back has been presented by McBride.[423] Conservative treatment of chronic lumbar backache has been outlined by Spithoff.[424]

Liston [425] has reported the vertebral defects, together with other abnormalities of the musculoskeletal system, which were observed in a large number of men who were examined for air crew training. Friedman, Fischer and Van Demark [426] have recorded the incidence of roentgenographic abnormalities of the lumbosacral region of the spine in 100 soldiers who had no backache. Moore,[427] reporting from a naval hospital, has presented a study of 550 cases of backache; in 4.8 per cent of these the condition was diagnosed as spondylolisthesis and in 5.3 per cent as lumbosacral instability. From these figures and from hospitalization statistics he concluded that applicants for military service should have routine roentgenographic examination of the lumbosacral structures.

Considerable effort is being made to lessen the problem of industrial injuries of the back by job placement based on the findings of preemployment examinations. O'Connor [428] has described a routine appraisal of physical capacity based on history, physical examination and, when indicated, roentgenograms of the back. Such analysis made it possible to employ each person in a job suited to his physical capacity; this policy resulted in a gratifying decrease in the incidence of back strains. Barton and Biram [429] analyzed anteroposterior and lateral roentgenograms of the lumbosacral region of the spine made during 1,000 consecutive preplacement examinations. Eight hundred and fifty-six defects were found in 498 of the persons examined. The authors believe that spondylolisthesis, arthritis and in some cases spina

421. Lee, A. E.: Low Backache, M. J. Australia **1**:42-44 (Jan. 12) 1946.

422. Larochelle, J. L.: Lumbalgia With or Without Sciatica, Laval méd. **11**:505-510 (May) 1946.

423. McBride, E. D.: Examination of Back: Diagnostic Outline for Standardized Routine, South. M. J. **39**:867-876 (Nov.) 1946.

424. Spithoff, C. A.: Chronic Lumbar Backache, Am. J. Surg. **71**:19-25 (Jan.) 1946.

425. Liston, E.: Diseases and Defects of Musculoskeletal System in Air-Crew Trainees, J. Bone & Joint Surg. **28**:466-472 (July) 1946.

426. Friedman, M. M.; Fischer, F. J., and Van Demark, R. E.: Lumbosacral Roentgenograms of One Hundred Soldiers: Control Study, Am. J. Roentgenol. **55**:292-298 (March) 1946.

427. Moore, M., Jr.: Military Importance of Low Back Disability, Mil. Surgeon **98**:235-236 (March) 1946.

428. O'Connor, R. B.: Physical Capacities Appraisal of Industrial Back, Indust. Med. **15**:639-640 (Nov.) 1946.

429. Barton, P. N., and Biram, J. H.: Replacement Examination of Lower Back, Indust. Med. **15**:319-322 (May) 1946.

bifida occulta and transitional lumbosacral vertebrae are significant contributing factors in back strains in workers more than 45 years of age.

Several articles have been devoted to the influence of inequality of the lengths of the lower extremities in producing pain low in the back. Rush and Steiner [430] have reported a roentgenographic study of length inequality of the lower extremities in 1,000 soldiers who were complaining of pain in the lower part of the back. Anteroposterior and lateral roentgenograms of the pelvis and hips were made with the patient standing; the standing position was standardized by the use of an adjustable support fitting into the mouth. The relative lengths of the lower extremities were measured on the anteroposterior films. No roentgenographic lesions were found in the roentgenograms of the back in a majority of the cases in which there was unequal length of the legs; the authors consider it possible that the symptoms of these patients were associated with the inequality of the length of the legs. Among a group of 100 soldiers who had no pain in the lower part of the back the incidence of inequality in the length of the legs, the degrees of inequality and the roentgenographic incidence of lesions in the lower part of the back were less than in the group of cases in which there was pain in the lower part of the back. Stuckey [431] found inequality of the lengths of the legs in 26 of 40 soldiers who suffered from backache; he states the belief that the short leg is an important factor in the causation of pain in the back. Articles on this subject have also been published by Butler [432] and by Montant.[433]

The influence of the orthograde position and the importance of faulty posture as an underlying cause of pain in the lower part of the back have been stressed by Meehan.[434] For the treatment of most patients he recommends rest, manipulation and postural exercises.

Backache in women has been discussed by several authors. Geisendorf [435] has written on painful lesions of the spine in females, and

430. Rush, W. A., and Steiner, H. A.: Study of Lower Extremity Length Inequality (Using Spinal Fixation and Stabilization Device for Roentgenography), Am. J. Roentgenol. **56**:616-623 (Nov.) 1946.

431. Stuckey, D.: Backache in Soldiers, M. J. Australia **1**:838-842 (June 15) 1946.

432. Butler, J. M.: Short Leg Backache, Journal-Lancet **66**:10-11 (Jan.) 1946.

433. Montant, R.: Backache: Late Sequels of Post-Traumatic Shortening of Lower Extremities; Disorders of Lumbosacral Region, Helvet. med. acta **9**:745-786 (Dec.) 1942.

434. Meehan, A. V.: Low Back Pain, M. J. Australia **1**:40-42 (Jan. 12) 1946.

435. Geisendorf, W.: Lesions and Backache in Women, Praxis **35**:327-330 (May 23) 1946.

Moreno [436] has considered the relationships of climacteric and pelvic changes to lumbago and sciatica. McCall [437] and Font Sastre [438] have pointed out the influence of relaxation of the joints of the pelvis during pregnancy. McCall ascribes postpartum backache to residual changes in the joints, loss of muscle tone and long hours of standing and walking. Gynecologic back pain, according to McCall, is located in the midline in the region of the sacrum and almost never reaches a higher level. It may be caused by (1) inflammatory changes in the pelvic organs and particularly in the uterosacral ligaments; (2) traction exerted by a pyosalpinx, vaginal relaxation, cystocele, rectocele or prolapse; (3) congestion of the uterus and associated structures, and (4) pressure of tumors.

A number of articles in the foreign literature have been devoted to the influence of arthritis and allied conditions in the causation of pain in the lower part of the back. Franceschelli,[439] Lachapèle [440] and Longhi and Zanuso [441] have discussed changes in the intervertebral articulations. Pouyanne [442] has written on "vertebral rheumatism" and Portela [443] on traumatic lumbago. Abnormal relationship of the lower lumbar spinous processes (interspinous osteoarthrosis, Baastrup's disease or kissing spine) is the subject of a report by Mouchet.[444] For this condition a clinical syndrome of midline backache, pain on motion of the lumbar region of the spine, increased lumbar lordosis, diminished mobility and pain on pressure over the spinous processes has been described; roentgenograms are said to show a decreased interval between the spinous processes and sclerosis of their adjacent margins. Patients whose symptoms have not responded to conservative measures have

436. Moreno, B. A.: Lumbagos and Sciaticas: Relation to Climacteric and Pelvic Changes in Female, Bol. d. Inst. clin. quir. **22**:57-67 (Jan.-July) 1946.

437. McCall, M. L.: Symposium on Recent Advances in Gynecology: Backache in Women and Uterine Retrodisplacement, S. Clin. North America **25**: 1313-1323 (Dec.) 1945.

438. Font Sastre, V.: Symphysis Pubis: Painful Relaxation and Separation of Pelvic Joints During Pregnancy, with Report of Cases, Rev. españ. obst. y ginec. **4**:15-24 (Jan.) 1946.

439. Franceschelli, N.: Lumbago, Sciatica and Arthroses (Apophysial, Intersomatic): Physiopathologic Study, Arch. ortop. **56**:181-211 (Sept.) 1940.

440. Lachapèle, A. P.: Backache: Role of Posterior Vertebral Articulations, Rev. du rhum. **13**:214-217 (July) 1946.

441. Longhi, L., and Zanuso, F.: Apophysial Arthritis of Lumbosacral Region, Rassegna d. previd. sociale (no. 12) **27**:16-127 (Dec.) 1940.

442. Pouyanne, L.: "Vertebral Rheumatism" and Lumbar Pain, Rev. du rhum. **13**:195-199 (July) 1946.

443. Portela, C. J.: Traumatic Lumbago, Bol. Liga urug. contra el reumat. **1**:228-234 (July) 1945.

444. Mouchet, A.: Interspinous Osteoarthrosis (Baastrup's Disease, "Kissing Spine"), Paris méd. **2**:321-323 (July 27) 1946.

been treated by partial or total resection of the affected spinous processes or by spinal fusion.

In some quarters a revival of interest in possible lesions of the sacroiliac joints is to be noted. Caro and Ingber [445] have discussed the clinical value of roentgenographic examination of the sacroiliac joint. Travell and Travell [446] state their belief that slipping of the sacroiliac joint is a common cause of pain low in the back; they treat their patients by injection of procaine hydrochloride into trigger points and by manipulation. Bidwell [447] similarly expresses the opinion that unilateral sacroiliac subluxation or displacement is a major cause of pain in the lower part of the back; his patients are treated by manipulation, bed rest, restricted exercise and in some instances low back supports. He reports that 140 of 146 patients so treated were relieved of their symptoms. Sierra Cano, Sanchez Trallero, and Sala de Pablo [448] have written on the surgical treatment of conditions involving the sacroiliac joint. An article on sacroiliac strain and its treatment by arthrodesis according to the technic of Smith-Petersen has been published by Newman.[449] The operations were performed by Bankart. Newman believes that sacroiliac strain is a definite syndrome which can and should be differentiated from syndromes involving the lumbar region of the spine. He states that the nature of injury is often a torsion strain in either the standing or the sitting position. He thinks that sacroiliac strain is uncommon in the male and that it occurs almost invariably in females between the ages of 15 and 45 years. There may be a history of creaking, especially on sitting down, which is localized accurately to the sacroiliac joint. However, the main point in diagnosis, according to Newman, is the site of pain and tenderness; this is a small area just medial to the posterior superior spine of the ilium or at the upper margin of the great sciatic notch. Radiating pain may involve the lumbosacral area, the groin and the lateral area of the thigh, the posterior part of the thigh and the leg or the lateral aspect of the buttock. Newman believes that the symptoms are associated with abnormal mobility of the sacroiliac joint. He advises first one or more manipulations and states the belief that sacroiliac arthrodesis

445. Caro, D. L., and Ingber, E.: Sacroiliac Joint: Clinical Value of Roentgen Exploration, Rev. argent. de reumatol. **10**:332-343 (March) 1946.

446. Travell, J., and Travell, W.: Therapy of Low Back Pain by Manipulation and of Referred Pain in Lower Extremity by Procaine Infiltration, Arch. Phys. Med. **27**:537-547 (Sept.) 1946.

447. Bidwell, A. M.: Treatment of Sacroiliac Sprain by Manipulation: Report of One Hundred and Forty-Six Cases, J. Florida M. A. **33**:193-196 (Oct.) 1946.

448. Sierra Cano, L.; Sanchez Trallero, A., and Sala de Pablo, J.: Sacroiliac Joint: Surgical Therapy, Rev. espan. cir. **2**:257-266 (Oct.) 1945.

449. Newman, P. H.: Sacro-Iliac Arthrodesis, Proc. Roy. Soc. Med. **39**: 715-718 (Sept.) 1946.

is indicated if the symptomatic response to manipulation is unsatisfactory. Thirty-six arthrodeses were performed on 32 patients during a period of ten years; over an average follow-up period of four years twenty-one cures were recorded out of a group of thirty-three operations.

[ED. NOTE (R. B. R.).—A few years back, large numbers of patients with pain in the lower part of the back and sciatic pain were treated in this country by sacroiliac arthrodesis. Many were relieved, but the number who did not obtain satisfactory or permanent relief was considerable. Thanks to recent advances in the diagnosis of conditions involving this area, it is now possible in most cases to localize traumatic lesions, with considerable confidence, in structures less stable than the strong sacroiliac joints. I believe that sacroiliac subluxation is uncommon and that for pain low in the back or sciatic pain of mechanical origin sacroiliac arthrodesis is rarely indicated.]

Painful disorders of the adipose tissue of the back have received attention. Murphy [450] has reviewed the anatomy of fatty tissue in and about the structures of the back, Lifvendahl [451] has called attention to his investigation of this subject in 1937, and Clavero Núñez [452] has recorded a case of painful symmetric lipomas. Herz [453] has reported on 31 patients who were relieved of back pain after the excision of small masses of fatty tissue which had herniated through weak points in the superficial fascia. The clinical picture included a history of injury or strain, severe pain in the lower part of the back which in some cases radiated down one of the lower extremities, a palpaple nodule, and relief obtained by the injection of procaine hydrochloride. Microscopic examination of the excised tissue did not reveal definite abnormality.

Sargent [454] has reported the case of a soldier in whom pain in the lower part of the back developed when he lifted a machine gun and in whom a small tender mass over the sacrospinalis muscle was seen on examination. Surgical exploration revealed a small herniation of the sacrospinalis through a tear in the posterior layer of the lumbodorsal fascia. Repair of the herniation was followed by complete relief of the back pain.

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450. Murphy, E.: Low Backache, M. J. Australia **1**:44-45 (Jan. 12) 1946.

451. Lifvendahl, R. A.: Herniation of Fascial Fat and Low Back Pain, Correspondence, J. A. M. A. **130**:107 (Jan. 12) 1946.

452. Clavero Núñez, A.: Disorders of Adipose Tissue as Cause of Lumbosacralgias in Women: Symmetric Lipomas as Cause of Backache in Case, Rev. españ. obst. y ginec. **3**:266-269 (Oct.) 1945.

453. Herz, R.: Herniation of Subfascial Fat as Cause of Low Back Pain: Results of Surgical Treatment in Thirty-One Cases, J. Internat. Coll. Surgeons **9**:339-346 (May-June) 1946.

454. Sargent, M.: Localized Back Pain: Separation of Fibers of Posterior Layer of Lumbodorsal Fascia with Herniation of Sacrospinalis Muscle as Cause, Am. J. Surg. **71**:338-339 (March) 1946.

Kabat and Jones [455] have reported the use of neostigmine in the treatment of 47 cases of pain in the lower part of the back attended by muscle spasm. The authors thought that significant relief from pain and improvement in range of motion took place.

Study of a case of sacralization in a child has been recorded by Puig Serrate.[456] Barba Inclán [457] has written on the subject of stubborn coccygodynia.

A number of case reports serve to remind the orthopedist that pain in the lower part of the back may be the chief or the sole symptom of visceral disease. Cases of retroperitoneal tumor, pancreatic tumor, duodenal ulcer, ileitis, hiatus hernia and aerophagia in which pain low in the back was the outstanding symptom have been reported by Trumen and Yaskin.[458] Important features of the back pain in these cases were aggravation in the supine position, increased pain at night and relief on flexion of the spine. Muscle spasm, stiffness of the spine and deformity of the back were absent. In many of these cases the complaint of back pain in the absence of physical signs of a lesion had led to an erroneous diagnosis of neurosis. The authors point out that pain of obscure origin in the lower part of the back, especially in the absence of orthopedic signs, always calls for consideration of a lesion of the gastrointestinal tract and a diagnostic search for such a lesion. Kattwinkel [459] has reported a case of carcinoma of the body of the pancreas, with presenting symptoms of epigastric distress and back pain. The pain was aggravated by recumbency and relieved by flexion of the spine. A case of bilateral carcinoma of the adrenal glands in which severe lumbar backache was the outstanding symptom has been reported by Zaslow and Bernstein.[460] Howard [461] has called attention to pain low in the back resulting from retroperitoneal pelvic lymphangitis.

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455. Kabat, H., and Jones, C. W.: Neuromuscular Dysfunction: Neostigmine Therapy of Acute and Chronic Backache, Arch. Phys. Med. **27**:208-218 (April) 1946.

456. Puig Serrate, J.: Symptomatic Study of Sacralization in Child: Case, Rev. españ. pediat. **2**:405-412 (May-June) 1946.

457. Barba Inclán, A.: Stubborn Coccygodynia, Bol. Sec. san. policía nac. **1**: 135-139 (Oct.-Dec.) 1945.

458. Trumen, H. J., and Yaskin, J. C.: Backache Due to Intra-Abdominal Disease, Gastroenterology **7**:294-305 (Sept.) 1946.

459. Kattwinkel, E. E.: Back Pain as Symptom of Carcinoma of Body of Pancreas, Ann. Int. Med. **23**:1006-1009 (Dec.) 1947.

460. Zaslow, J., and Bernstein, M.: Bilateral Carcinoma of Adrenal Cortex as Cause of Severe Backache with Report of Case, J. Urol. **54**:409-412 (Nov.) 1945.

461. Howard, H. W.: Retroperitoneal Lymphangitis, Tr. West. Sect., Am. Urol. A. **12**:81-82, 1944; Urol. & Cutan. Rev. **50**:26-27 (Jan.) 1946.

Psychiatric causes of pain in the lower part of the back have been discussed by Sargent.[462] In the differential diagnosis of such pain, the fact that backache is a frequent complaint in anxiety states should always be kept in mind.

The anatomy, development and growth of human sacral vertebrae have been investigated by Giraudi,[463] and the topography of the sacroiliac joints has been studied by Tesoriere.[464] Lanier and Trotter [465] have found the volume of the sacral canal to be greater in men than in women and greater in white than in Negro subjects.

A case of "iliac horns" has been reported by Fong.[466] These processes arose from the posterior surface of the ilia, measuring 2.5 cm. in diameter and projecting 3 cm. laterally and posteriorly. They were easily palpable and caused no symptoms. Associated findings were unusual obliquity of the inferior halves of the sacroiliac joints, rather horizontal lumbosacral joints and an anthropoid type of pelvic inlet. In an addendum to Fong's article the editor of *Radiology* cites a similar case.

The "transverse sacral fold," an abnormal bony sulcus on the posterior aspect of the sacrum, has been found by Trotter and Heath [467] in 10 of 1,227 sacrums. Each of these 10 sacrums was from a female skeleton; none of 553 male sacrums showed this change. The transverse fold is believed to be a result of anomalous congenital development or of a pathologic fracture in middle or late adult years. The latter view is supported by the age and by the osteoporosis and associated fractures which characterized the 10 skeletons whose sacrums were involved. Narrowing of the posterior sacral foramens was found in association with the transverse folds; the authors are of the opinion that this may be of clinical significance in causing sensory changes and slight muscular atrophy.

*Sciatica.*—Again a number of articles require indexing under this designation. These papers are from the foreign literature; many report only a single case and several have not been available for review.

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462. Sargent, M.: Psychosomatic Backache, New England J. Med. **234**:427-430 (March 28) 1946.

463. Giraudi, G.: Microscopic and Roentgenologic Study of Development and Growth of Human Sacral Vertebrae, Arch. ortop. **56**:77-103 (July) 1940; Anatomic (Macroscopic and Microscopic) and Roentgenologic Study of Sacral Vertebrae, ibid. **56**:221-254 (Sept.) 1940.

464. Tesoriere, A.: Sacroiliac Joint: Topography; Anatomicosurgical Study, Policlinico (sez. chir.) **52**:165-177 (Sept.-Oct.) 1945.

465. Lanier, P. F., and Trotter, M.: Volume of Sacral Canal, Am. J. Phys. Anthropol. **4**:227-233 (June) 1946.

466. Fong, E. E.: "Iliac Horns" (Symmetrical Bilateral Central Posterior Iliac Processes): Case Report, Radiology **47**:517-518 (Nov.) 1946.

467. Trotter, M., and Heath, R. D.: Transverse Sacral Folds, J. Bone & Joint Surg. **28**:120-125 (Jan.) 1946.

Sciatica has been discussed by Rogers,[468] Obarrio [469] and Edler.[470] A statistical study of age and sex in cases of sciatic neuralgia has been published by Roger and Schachter,[471] and Costa Bertani [472] has writiten on the casuistics of medical sciatica.

Little [473] has divided the types of sciatica into a first group without neurologic signs and a second group characterized by their presence; the second group he subdivides into (1) sciatic neuritis of infectious, toxic or metabolic origin and (2) sciatica due to mechanical disturbance of nerve roots by lesions such as spondylolisthesis or protrusion of an intervertebral disk. As an aid in diagnosis, Little uses a "thumb sign"—pain or paresthesia radiating into some part of the dermatome when firm pressure is made over an interspace 1 inch (2.5 cm.) from the midline.

Holmes and Sworn [474] express the belief that sciatica may be caused by any of a variety of lesions which may affect different levels of the nerves. Within the spinal canal pressure on the nerve root is the commonest cause of symptoms; arthritis of the intervertebral joints may be the most frequent lesion affecting the nerve root in its course through the intervertebral foramen; fibrositis is considered probably responsible for involvement of the nerve after it has emerged from the vertebral column. Although each of the three main levels of nerve involvement tends to produce its characteristic clinical picture, the differential diagnosis is not easy and may be made only by myelography or surgical exploration. The authors present a series of 50 patients who were operated on for the relief of pain attributed to an intraspinal lesion; the most common finding (in 54 per cent of the cases) was a ruptured intervertebral disk.

A consideration of the pathogenesis of sciatica has been published by de Sèze.[475] Sicard and Gaucher [476] have reported a case of stubborn

468. Rogers, L.: Sciatica, J. Roy. Nav. M. Serv. **32**:209-211 (July) 1946.

469. Obarrio, J. M.: Stubborn Sciatics: Symptomatology and Diagnosis, Rev. argent. de reumatol. **11**:118-137 (Aug.) 1946.

470. Edler, K.: Sciatica Therapy in Daily Practice, Wein. med. Wchnschr. **96**:392 (Oct. 1) 1946.

471. Roger, H., and Schachter, M.: Statistical Study on Role of Age, Sex, and Localization in Sciatic Neuralgia, Rev. neurol. **77**:197-198 (July-Aug.) 1945.

472. Costa Bertani, G.: Medical Sciaticas: Casuistics, Rev. argent. de reumatol. **11**:86-116 (July) 1946; Rev. Asoc. méd. argent. **60**:464-472 (June 15) 1946.

473. Little, N.: Some Further Observations on Sciatica, M. J. Australia **1**: 33-37 (Jan. 12) 1946.

474. Holmes, J. M., and Sworn, B. R.: Lumbosacral Root Pain, Brit. M. J. **1**:946-948 (June 22) 1946.

475. de Sèze, S.: Anatomic and Physiopathologic Unity in Common Vertebral Sciatica Whether Due to Disk Herniation or Not, Semaine d. hôp. Paris **22**:1090-1093 (June 21) 1946.

sciatica attributed to fracture of an articular apophysis; Costa Bertani [477] has described a case of sciatic pain which persisted after operation for hypertrophied ligamentum flavum and subsided after medical treatment. Ramond [478] has recorded a case of sciatica attributed to tumor of the spinal cord; Diez [479] has described 2 cases of stubborn sciatica attributed to intraspinal extradural neurinoma and 1 case attributed to von Recklinghausen's neurofibromatosis of the cauda equina.

Baastrup [480] has suggested that in some instances sciatic pain may be caused by inflammatory changes in peritendinous or bursal tissues deep in the gluteal region; he points out certain data which may be considered to support such a hypothesis. Sciatica of uterine origin is the subject of a case report by Astarloa, Peyceré and Nessi.[481]

Referred pain in the distribution of the fourth lumber root, resulting from osteoarthritis of the hip, has been investigated by von Reis [482]; he found that considerable relief of such pain could be provided by rhizotomy. Wertheimer and Gautier [483] have presented the results of thirty-four operations for stubborn sciatica. A surgical technic for exposure of the sciatic nerve high under the gluteus maximus muscle has been described by Aird.[484]

*Intervertebral Disks.*—The role of the normal and the pathologic disk in intervertebral mobility has been studied bu Knutsson.[485] Lateral

476. Sicard, A., and Gaucher, M.: Stubborn Sciatica Due to Fracture of Articular Apophysis: Case, Presse méd. **54**:412-413 (June 22) 1946.

477. Costa Bertani, G.: Sciatica, Persisting After Operation for Hypertrophy of Yellow Ligament, Cured by Medical Treatment: Case, Rev. Asoc. méd. argent. **60**:584-587 (July 15) 1946.

478. Ramond, L.: Sciatica: Case Due to Tumor of Spinal Cord, Presse méd. **54**:530 (Aug. 10) 1946.

479. Diez, J.: Stubborn Sciatica Due to Intraspinal Extradural Neurinoma: Two Cases, Rev. Asoc. méd. argent **60**:171-173 (April 15) 1946; Stubborn Sciatica Due to Recklinghausen's Neurofibromatosis of Cauda Equina: Case, ibid. **60**:273-275 (May 15) 1946.

480. Baastrup, C. I.: Possible Relation of Peritendinitis and Bursitis to So-Called Sciatica, Nord. med. **16**:3668-3672 (Dec. 26) 1942.

481. Astarloa, E.; Peyceré, F. P., and Nessi, C. T.: Sciatica: Uterine Origin; Case, Prensa méd. argent. **33**:1560-1561 (July 26) 1946.

482. von Reis, G.: Sciatica: Pain in Distribution Area of Fourth Lumbar Root; Study of Pain Interpreted as Referred Pain and as Caused by Direct Irritation of Nerve Root, Acta psychiat. et neurol., 1945, supp. 36, pp. 1-135.

483. Wertheimer, P., and Gautier, R.: Comparative Results and Statistics on Thirty-Four Surgical Interventions for Stubborn Sciatica, Lyon chir. **41**:33-40 (Jan.-Feb.) 1946.

484. Aird, I.: Exposure of High Lesions of Sciatic Nerve, Surg., Gynec. & Obst. **83**:369-372 (Sept.) 1946.

485. Knutsson, F.: Slight and Severe Instability States of Lumbar Spine in Disk Degeneration, Nord. med. **31**:1875-1876 (Aug. 23) 1946.

roentgenograms of the normal spine were made with the subject standing in maximum flexion and then in maximum hyperextension; the increased pressure incident to movement was transmitted fairly uniformly throughout the cross section of the disk. The normal disk permits angulation between the vertebrae but sharply restricts parallel displacement. The pathologic disk fails to prevent abnormal tilting and parallel displacement from taking place on motion. Such abnormal movements may contribute to sclerosis of the surfaces of the vertebrae and to lipping of their edges. In 58 of 140 patients the roentgenograms showed anatomic changes which were attributed to degeneration of the disks. Parallel displacement of the overlying vertebrae occurred on backward bending in 8 cases, and slight anterior displacement or pseudospondylolisthesis was noted in 8 cases. In 18 cases parallel displacements were observed in the absence of other signs of degeneration of the disks. Knutsson thought that these patients had incipient degeneration of the disks and that in many instances careful roentgenographic study of such changes might lead to early diagnosis.

Gershon-Cohen [486] has reported on 3 patients who sustained severe injuries followed by incapacitating low backache for several weeks, without evidence of fracture or dislocation or posterior protrusion of an intervertebral disk. Two of the patients had recurring episodes of pain in the lower part of the back. Subsequently, physical examination showed only slight restriction of lumbosacral mobility, and roentgenograms showed narrowing of the disk space, increased density of the subchondral bone and radiolucence of the disk space, which the author regards as a vacuum phenomenon. Gershon-Cohen discusses these findings, using the term "phantom nucleus pulposus." It is conceivable that loss of nuclear material may take place through an abnormal annulus fibrosus, through defects in the cartilage plates or through a process of degeneration and desiccation.

[ED. NOTE (R. B. R.).—The pathogenesis of extreme narrowing of the lumbosacral disk has not been established. Pain in the lower part of the back associated with this change is to be attributed to secondary malalinement of the facet joints and may be relieved or abolished by an efficient flexion support or by lumbosacral fusion.]

The importance of abnormalities of the intervertebral disks in the causation of backache is receiving increased recognition. Hyndman [487] has discussed this subject in considerable detail and has presented a classification of degenerative lesions of the disks. He believes that

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486. Gershon-Cohen, J.: Phantom Nucleus Pulposus, Am. J. Roentgenol. **56**: 43-48 (July) 1946.

487. Hyndman, O. R.: Pathologic Intervertebral Disk and Its Consequences: Cause and Treatment of Chronic Pain Low in Back, Arch. Surg. **53**:247-297 (Sept.) 1946.

degeneration of the disks is a predominant cause of chronic pain low in the back and that degeneration precedes herniation or rupture of the disk. He regards the syndrome of chronic pain in the lower part of the back and the syndrome of sciatica as distinct entities which result from the progressive development of a single pathologic process. Young [488] has analyzed the spinal mechanics, symptoms and signs in lumbago and has concluded that its probable cause is a lesion of the intervertebral disks. He doubts the existence of fibrositis as an entity and does not think that such a lesion can explain the clinical features of lumbago. In another article Young [489] has discussed the diagnosis and treatment of partial and complete tears of the annulus fibrosus and has stated his belief that in 90 per cent of cases of backache and in 95 per cent of cases of sciatica the condition is due to pathologic changes in intervertebral disks. Merlino [490] has discussed disorders of the disks as a cause of lumbar pain in women, and Argüelles [491] has written on the relationship between the ruptured disk and osteochondrosis.

Many reviews covering the more important aspects of the syndrome of the protruded intervertebral disk continue to be published. Love [492] has presented instances of protrusion at cervical, thoracic and lumbar levels of the spine and discussed the neurosurgical treatment. Experiences with ruptured lumbar disks in military personnel have been reviewed by Whitcomb [493] and by King.[494] Petit-Dutaillis [495] has reviewed a series of 170 patients who had sciatic pain and who were treated surgically; herniation of an intervertebral disk was found in 125 of the cases. Lindon [496] has described the changes found at operation in 72 patients for whom the preoperative diagnosis was a lesion of an intervertebral disk; the types of pathologic changes in the disks included

488. Young, J. H.: Lumbago, M. J. Australia **2**:485-488 (Oct. 5) 1946.

489. Young, J. H.: Recent Advances in Diagnosis and Treatment of Lumbar Disk Disease, M. J. Australia **1**:45-49 (Jan. 12) 1946.

490. Merlino, A.: Disorders of Disks as Cause of Lumbar Pain in Women, Riforma med. **60**:324 (June 30) 1946.

491. Argüelles, R.: Hernia of Nucleus Pulposus and Osteochondrosis, Rev. españ. cir., traumatol. y ortop. **3**:139-145 (Sept.) 1945.

492. Love, J. G.: Protruded Intervertebral Disk, S. Clin. North America **26**:997-1006 (Aug.) 1946.

493. Whitcomb, B. B.: Symposium on Problems in Postwar Medicine: Rupture of Disk, M. Clin. North America **30**:431-444 (March) 1946.

494. King, M. K.: Rupture of Lower Lumbar Intervertebral Disks, Am. J. Surg. **72**:161-165 (Aug.) 1946.

495. Petit-Dutaillis, D.: Surgical Sciatica and Its Therapy in Connection with One Hundred and Seventy Cases, Schweiz. med. Wchnschr. **75**:875-877 (Oct. 1) 1945.

496. Lindon, L.: Problems of Backache and Sciatica, M. J. Australia **2**:345-347 (Sept. 7) 1946.

obvious nuclear protrusions, organization of old protrusions and calcification in diseased disks. Lindon attributes no significance to so-called concealed disks. Trumble,[497] reviewing the diagnosis and treatment of ruptures of the disks, agrees with Lindon on this point. Reviews and discussions of the syndrome of the protruding disk have also been published by Berens,[498] Speigel,[499] Lewin,[500] Greenwood,[501] Perrot,[502] Fitte,[503] Fernández[504] and Thiébaut.[505] Wahren[506] has reported a surgically proved herniation of a disk which followed a minor injury of the back of a girl 12 years of age.

Two articles deal with the medicolegal aspects of herniated disks. Barr and Craig,[507] after reviewing the disk syndrome, point out that the percentage of unsatisfactory postoperative results is much greater in insurance cases than in cases in which the patients are not seeking compensation for their injuries. Since the most frequent source of permanent disability is persistent pain and since the pain threshold varies in different persons, the estimation of permanent disability is difficult. Snellman[508] has enumerated criteria which determine the legal compensability in cases of herniation of disks.

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497. Trumble, H. C.: Some Aspects of Diagnosis and Treatment of Prolapsed Intervertebral Discs, Australian & New Zealand J. Surg. **15**:159-165 (Jan.) 1946.

498. Berens, S. N.: Ruptured Disc Syndrome: Is It an Orthopedic or Neurosurgical Problem? J. Omaha Mid-West Clin. Soc. **7**:63-69 (Aug.) 1946.

499. Speigel, I. J.: Herniation: Systematized Technic for Investigation and Treatment of Lumbosacral and Low Lumbar Lesions, Illinois M. J. **89**:188-196 (April) 1946.

500. Lewin, W.: Sciatica and Prolapsed Intervertebral Disc, M. Press **214**: 392-395 (Dec. 19) 1945.

501. Greenwood, J., Jr.: Protruded Intervertebral Disc, M. Rec. & Ann. **40**: 1289-1290 (Feb.) 1946.

502. Perrot, A.: Backache and Sciatica of Diskal Origin: Pathogenesis, Clinical Aspects and Therapy, Praxis **35**:169-173 (March 15) 1946.

503. Fitte, M. J.: Lumbagos and Lumbar Sciaticas, Especially Resulting from Herniated Disk: Cases, Bol. y trab., Soc. de cir. de Córdoba **6**:367-384, 1945.

504. Fernández, L. L.: Post-Traumatic Protrusion of Lumbosacral Disks: General Reflections on Lumbagos and Sciaticas, with Report of Case, Prensa méd. argent. **33**:1397-1403 (July 5) 1946.

505. Thiébaut, F.: Is Hernia of Disk the Cause or Result of Sciatica? Paris méd. **2**:417-419 (Sept. 21) 1946.

506. Wahren, H.: Herniated Nucleus Pulposus in Child of Twelve Years, Acta orthop. Scandinav. **16**:40-42, 1945.

507. Barr, J. S., and Craig, W. M.: Ruptured Disks, J. Nerv. & Ment. Dis. **103**:688-701 (June) 1946.

508. Snellman, A.: Pathogenesis of Disk Prolapse in Lumbar Region of Spine and Question of Compensation for Resulting Morbid Condition, Nord. med. (Duodecim) **27**:1517-1523 (Aug. 3) 1945.

The diagnosis of ruptured disks is the subject of a group of articles concerned with the clinical findings and of another group devoted to analysis of the roentgenographic findings.

Fincher [509] has reviewed more than 1,500 neurosurgical records of patients who had pain in the lower part of the back or in the lower extremities; the majority proved to have lesions of the intervertebral disks, while most of the remaining patients suffered from psychologic dysfunction, spinal cord tumor or metastatic tumor. The author discusses the differential diagnosis of these four major entities. In another article Fincher [510] has reviewed the differential diagnosis of ruptured disks and intraspinal tumors in the lumbosacral region. Ray [511] has presented case reports illustrating the differential diagnosis of ruptured disk, intradural tumor, radiculitis of various types, intraspinal extradural tumor and extraspinal nerve lesions. O'Connell [512] has discussed the pathologic changes which account for variations in the radiating pain associated with ruptured disks and has reviewed the indications for surgical treatment. Radicular pain due to herniation of a disk and its value in clinical diagnosis have also been discussed by de Sèze, Guillaume and Boulard.[513] Antoni [514] has reviewed the technic of the neurologic examination in cases of lumbago and sciatica, with especial consideration of the reflexes of the lower half of the body. Donaghy [515] has described the posterior tibial reflex, which is elicited by tapping on the tendon just above and behind the tibial malleolus, and has evaluated its usefulness as a localizing sign. This reflex is not demonstrable in many normal persons; however, its diminution or absence in one leg

509. Fincher, E. F.: Neurosurgical Experiences in Lumbago-Sciatic Syndrome, South. M. J. **39**:527-536 (July) 1946.

510. Fincher, E. F.: Differential Diagnosis of Intervertebral Cartilage Ruptures and Intraspinal Tumors Within Lumbar Sacral Canal, South. Surgeon **12**:292-304 (Nov.) 1946.

511. Ray, B. S.: Differential Diagnosis of Ruptured Lumbar Intervertebral Disk, S. Clin. North America **26**:272-281 (April) 1946.

512. O'Connell, J. E. A.: Clinical Diagnosis of Lumbar Disk Protrusions with Indications for Their Operative Removal, Brit. M. J. **1**:122-124 (Jan. 26) 1946.

513. de Sèze, S. G.; Guillaume, J., and Boulard, P.: Radicular Sciatica Due to Hernia of Intervertebral Disk at Level of Fifth Lumbar or First Sacral Vertebra: Basis of Clinical Diagnosis, Bull. et mém. Soc. méd. d. hôp. de Paris **62**:347-349, 1946; Radicular Syndrome of Fifth Lumbar and First Sacral Disks: Value of Clinical Findings for Determining Radicular Topography and Hernias of Intervertebral Disks Without Aid of Lipiodol (Iodized Oil), Semaine d. hôp. Paris **22**:1071-1087 (June 21) 1946.

514. Antoni, N.: Technic of Neurologic Examination in Lumbago and Sciatica, with Special Consideration of Reflexes of Lower Half of Body, Nord. med. (Hygeia) **20**:2077-2080 (Nov. 27) 1943.

515. Donaghy, R. M. P.: Posterior Tibial Reflex of Some Value in Localization of Protruded Disk in Lumbar Region, J. Neurosurg. **3**:457-459 (Sept.) 1946.

in the presence of an active reflex in the other leg is considered by Donaghy to be suggestive of a lesion at the interspace between the fourth and fifth lumbar vertebrae. Since the knee and ankle jerks are likely to be normal, the posterior tibial reflex may prove to be of considerable diagnostic value. Money [516] recommends the diagnostic injection of procaine solution through the sacral hiatus after a second needle has been placed in the third lumbar interspace. If the sciatica is due to a lesion peripheral to the exit of sacral or lumbar nerves from the foramens, the pain is first slightly increased and then relieved by the injection; if the sciatica is due to a root lesion, each injection, by increasing the pressure on the root, causes an exacerbation of the original pain.

A number of articles have been devoted to the roentgenographic diagnosis of protrusions of disks. Gillespie [517] analyzed 160 cases of proved lesions of the disks and was impressed with the diagnostic value of ordinary roentgenograms; the most useful findings were narrowing of the intervertebral space and localized osteoarthritic changes. Peterson [518] and Lindblom [519] have also discussed the roentgenographic diagnosis. "Pantopaque" myelography is the subject of articles by Maltby and Pendergrass,[520] Copleman,[521] Rocca and Cordero,[522] and Lange and Zaclis [523]; in addition, Andolf and Eneroth [524] have written on myelography with a water-soluble contrast medium.

Peacher and Robertson [525] have investigated the absorption of "pantopaque" by making roentgenograms at intervals after myelography. Roentgenograms of the skull showed small amounts of the contrast medium in the basal cisterns in nearly one fourth of the patients. A single benign meningeal reaction occurred after intracranial progres-

516. Money, R. A.: Sciatica, M. J. Australia **1**:37-40 (Jan. 12) 1946.

517. Gillespie, H. W.: Radiologic Diagnosis of Lumbar Disk Lesions: Report on One Hundred and Sixty Cases, Brit. J. Radiol. **19**:420-428 (Oct.) 1946.

518. Peterson, H. O.: Value of X-Ray Examination in Diagnosis of Ruptured Disk, Minnesota Med. **29**:904 (Sept.) 1946.

519. Lindblom, K.: Roentgen Diagnosis of Prolapse, Nord. med. **30**:1173-1176 (May 31) 1946.

520. Maltby, G. L., and Pendergrass, R. C.: Pantopaque (Iodine Preparation) Myelography: Diagnostic Errors and Review of Cases, Radiology **47**:35-46 (July) 1946.

521. Copleman, B.: Pantopaque Myelography: Indications and Technic, J. M. Soc. New Jersey **43**:460-461 (Nov.) 1946.

522. Rocca, E. D., and Cordero, R.: Pantopaque in Myelography, Arch. Soc. cirujanos hosp. **16**:394-397 (June) 1946.

523. Lange, O., and Zaclis, J.: Perimyelography with Pantopaque, Arq. neuropsiquiat., São Paulo **4**:133-141 (June) 1946.

524. Andolf, N., and Eneroth, S.: Herniated Disk and Myelography with Water-Soluble Contrast Medium, Nord. med. (Hygeia) **29**:23-27 (Jan. 4) 1946.

525. Peacher, W. G., and Robertson, R. C. L.: Absorption of Pantopaque (Iodine Preparation) Following Myelography, Radiology **47**:186-187 (Aug.) 1946.

sion of the "pantopaque." The rate of absorption of residual "pantopaque" seemed to be most rapid during the first four to six months.

James [526] has reported a case of narrowing of the third and fourth lumbar interspaces after lumbar puncture; the author suggests that the lumbar puncture may have caused collapse of the intervertebral disks. The patient, of unstated age, received a lumbar puncture for the investigation of convulsions. One week later he was hospitalized for rigidity and tenderness of the lumbar region of the spine, pain on flexion of the hips and a cautious gait. During the hospitalization chickenpox developed. Serial roentgenograms showed initially a narrowing of the third interspace and later a narrowing of the fourth interspace followed by erosion and finally sclerosis of the upper surface of the fourth lumbar vertebra. The patient was treated by plaster immobilization for six months.

[ED. NOTE (R. B. R.).—It seems unlikely that the disk changes were a result of lumbar puncture. Unfortunately the author does not state what interspace was punctured and whether any technical difficulty was encountered. Detailed, pertinent information is particularly desirable when the author's case is contrary to usual experience and an indictment of a commonly accepted form of treatment.]

The prognosis in cases of protruded disks is the subject of several articles. Dunning,[527] in a study of 55 cases, found that the neurologic signs and the protein content of the spinal fluid were of no prognostic value. The outlook for relief of pain appeared to be better when the first attack of sciatica occurred in the older age period. Of 60 patients operated on and reported by Schlin, Selverstone and Scribner,[528] 4 had bilateral herniations and 10 had multiple herniations; thus nearly one fourth of the patients had more than a single unilateral protrusion. In 5 cases the myelograms were noncontributory but ruptured disks were found at operation. The authors offer these facts in explanation of some of the unsatisfactory results of the treatment of ruptured disks. Three cases of recurrent herniation have been reported by Alajouanine and Thurel.[529]

An experimental study bearing on surgical treatment has been reported by Haas.[530] He found that in dogs the removal of an inter-

526. James, U.: Collapsed Disks Following Lumbar Puncture, Proc. Roy. Soc. Med. **39**:134-135 (Jan.) 1946.

527. Dunning, H. S.: Prognosis in So-Called Sciatic Neuritis, Arch. Neurol. & Psychiat. **55**:573-577 (June) 1946.

528. Schlin, F. A.; Selverstone, B., and Scribner, W. E.: Bilateral and Multiple Ruptured Disks as Cause of Persistent Symptoms Following Operation for Herniated Disk, Surg., Gynec. & Obst. **83**:485-493 (Oct.) 1946.

529. Alajouanine, T., and Thurel, R.: Recurrent Hernia: Three Cases, Rev. neurol. **78**:51-53 (Jan.-Feb.) 1946.

530. Haas, S. L.: Fusion of Vertebrae Following Resection, J. Bone & Joint Surg. **28**:544-549 (July) 1946.

vertebral disk by excision and curettage through an abdominal approach is followed by bony bridging between the adjacent vertebral bodies. Complete union prevented motion at the articular facets. Incomplete union produced considerable fixation of the bodies but allowed motion between the facets. In young growing animals the union was more rapid and more often of completely osseous quality. With bony union there was a tendency for buckling toward the spinal canal to take place.

Writing on the technic of disk operations, Clark [531] advocates removal of the herniated or degenerated disk in its entirety. He also removes as much as possible of the cartilage plates, using a side-cutting electrically driven burr in an attempt to produce union between the vertebral bodies. Clark reports 45 consecutive cases; in 30 he classifies the result as satisfactory, while 15 of the patients continued to have pain in the back on exertion. He attributed these failures to poor operative judgment, faulty technic or inadequate surgical instruments. [ED. NOTE (R. B. R.).—It seems not unlikely that the percentage of failures would have been less if the patients had had the benefit of fusion by one of the accepted posterior technics.] As an adjunct to spinal fusion by the time-tested interlaminal technic, Jaslow [532] drives a small peg of bone taken from a spinous process into the intercorporal space after removal of the disk and cartilage plates. He states the belief that this procedure maintains the height of the disk space, provides increased stability and tends to promote bony union.

Kalima [533] has recorded his technic of excising herniations of disks. It includes displacement of the nerve root medially when possible, electrocoagulation of veins on the surface of the herniation and thorough removal of disk tissue by means of especially designed instruments. Guillaume [534] also has described an operative technic for the treatment of lesions of the disk. Robertson and Peacher [535] have reported a technic for preserving and replacing the ligamentum flavum and an alternative procedure of covering the exposed interlaminar space with tantalum foil. Before adopting these measures they had found extensive adhesions from parapinous muscles down to the dura and the adjacent nerve roots in 10 of 12 backs which were reexplored because of per-

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531. Clark, F. J.: Recent Advances in Surgical Treatment of Lumbar Disk Disease, M. J. Australia **1**:49-52 (Jan. 12) 1946.

532. Jaslow, I. A.: Intercorporal Bone Graft in Spinal Fusion After Disk Removal, Surg., Gynec. & Obst. **82**:215-218 (Feb.) 1946.

533. Kalima, T.: Simple, Thorough Operative Technic for Excochleation of Disc Herniation, J. Internat. Coll. Surgeons **9**:531-535 (Sept.-Oct.) 1946.

534. Guillaume, J.: Simple Operative Technic in Diskal Sciatica, Rev. neurol. **78**:154-156 (March-April) 1946.

535. Robertson, R. C. L., and Peacher, W. G.: Herniation of Nucleus Pulposus: Refinement in Operative Technic, Surgery **18**:768-772 (Dec.) 1945.

sistent or recurrent symptoms. In 188 subsequent cases in which operation was performed by these technics the end results were superior to those in an earlier series. [ED. NOTE (R. B. R.).—Adequate occlusion of the interlaminar space is, of course, essential when excision of the disk is to be followed by spinal fusion with chip grafts.] Hirsch [536] has reported on 2 patients who had signs of nerve root compression although the myelograms revealed no abnormality; at operation on each the prolapsed disk was found in the intervertebral foramen. The intervertebral joints were resected and the disks removed, with satisfactory early relief of the symptoms. Fernández [537] has discussed the exploration of intervertebral disks in the course of fusion operations, and de Sèze, Guillaume, Boulard and Mazars [538] have described a technic for identifying the individual intervertebral space.

Reports of the end results of excision of disks, with or without arthrodesis, continue to be published; their interpretation is difficult, and in some respects their content is conflicting. Friberg and Hirsch [539] report a five year follow-up study of 44 patients who were operated on for prolapse of a lumbar disk. In 37 cases herniation had been demonstrated and in 5 cases disk degeneration; in 2 cases the findings were normal. Of the 44 patients, 42 were capable of work; 32 of these returned to their old jobs, which in 22 instances consisted of physical labor. Of 37 patients with proved herniations, 31 were free from sciatic pain. Spinal fusion was not done in any of these cases. All the patients complained of a certain amount of back discomfort for a period of one to three years after operation. The authors consider arthrodesis at the time of excision of the disk unnecessary but recommended it as a later procedure if the pain in the lower part of the back fails to subside satisfactorily. In 5 instances lesions of a disk were demonstrated at operation but postoperative roentgenograms showed no abnormality; the authors concluded that the state of the disks cannot always be properly evaluated on roentgenographic evidence alone. Reviews of

536. Hirsch, C.: Intervertebral Foraminotomy, Acta chir. Scandinav. **94**: 75-80, 1946.

537. Fernández, L. L.: Lumbagos and Lumbosciaticas: Exploration of Disk in Course of Lumbosacral Osseous Fusion, Prensa méd. argent. **33**:649-660 (March 29) 1946.

538. de Sèze, S.; Guillaume, J.; Boulard, P., and Mazars, G.: Technical Procedure Permitting Easy Identification of Intervertebral Space: Deep Preoperative Alignment Staining Under Radiologic Control; Step Forward in Minimizing Surgery for Sciatica, Bull. et mém. Soc. méd. d. hôp. de Paris **62**:179-180, 1946.

539. Friberg, S., and Hirsch, C.: Late Results of Operative Treatment for Disk Prolapses in Lumbar Region: Preliminary Report, Acta chir. Scandinav. **93**:161-168, 1946.

postoperative results have been published also by Samson and Jarry,[540] Lehmann,[541] and Briggs and Keats.[542] Diéz[543] has added 14 cases to his previously reported series. Compere[544] advocates interlaminar spinal fusion when the herniation of a disk is removed. He expresses the opinion that failure to protect the involved segments results during the course of the following one to five years in the development of osteoarthritic changes in the articular facets and margins of the vertebral bodies. He cites 3 cases in which fusion was not carried out and in which arthritic changes took place.

Two articles are concerned with end results in military personnel. White and Peterson[545] found that 75 per cent of a group of 39 officers and enlisted men were able to return to full or partial military duty after removal of a herniated disk. The authors think that the operation should be performed only in clearcut cases and on otherwise healthy persons who are eager to return to duty. Mayfield[546] has reviewed 126 cases of patients treated surgically for disk herniations. Seventy-four per cent returned to duty, and an additional 10 per cent were much improved. Mayfield advises spinal fusion in about 10 per cent of the cases; this group includes patients with spondylolisthesis, extensive local arthritis, defective local facets or persistent or recurrent symptoms following the previous removal of a protruding disk.

*Spondylolysis and Spondylolisthesis.*—Lerner and Gazin[547] examined the roentgenograms of 511 patients with pain in the back at an Army Air Force Regional Hospital; they found 52 instances of isthmus hiatus, in 19 of which spondylolisthesis was present. The authors believe that spondylolysis may be attended by sufficient instability to cause

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540. Samson, A., and Jarry, L.: Surgical Therapy of Hernia: Cases, Ann. méd.-chir. de l'Hôp. Sainte-Justine, Montréal **5**:109-116, 1946.

541. Lehmann, P. O.: Protruded Disk: Sixty Operative Cases, Bull. Vancouver M. A. **22**:56-60 (Dec.) 1945; J. Canad. M. Serv. **3**:244-250 (March) 1946.

542. Briggs, H., and Keats, S.: Clinical Experiences in Treatment of Low Back and Sciatic Pain Associated with Disorders of Intervertebral Disk, J. M. Soc. New Jersey **43**:13-18 (Jan.) 1946.

543. Diéz, J.: Stubborn Sciatica Due to Hernia of Disk: Late Results in Surgical Therapy of Fourteen Additional Cases, Bol. y trab., Acad. argent. de cir. **30**:459-496 (July 17) 1946.

544. Compere, E. L.: Fusion of Spine After Removal of Ruptured Disk, J. Internat. Coll. Surgeons **9**:14-19 (Jan.-Feb.) 1946; South. M. J. **39**:301-306 (April) 1946.

545. White, J. C., and Peterson, T. H.: Lumbar Herniations: Value of Surgical Removal for Naval Personnel, Occup. Med. **1**:145-159 (Feb.) 1946.

546. Mayfield, F. H.: Herniated Nucleus Pulposus: Protruded Disks, J. Michigan M. Soc. **44**:1206-1209 (Nov.) 1945.

547. Lerner, H. H., and Gazin, A. I.: Interarticular Isthmus Hiatus (Spondylolysis), Radiology **46**:573-578 (June) 1946.

degeneration of the intervertebral disk, which in turn may produce either spondylolisthesis or herniation of the disk. McMaster and Dula [548] have found 23 cases of spondylolysis among 350 patients with pain in the back.

Meyerding and Flashman [549] have reviewed briefly the subject of isthmus defects of the lumbar vertebrae and reemphasized the diagnostic value of oblique roentgenograms. They appended reports of 7 patients who complained of backache with little or no pain in the lower extremities and whose roentgenograms showed isthmus defects; in 4 of these patients grade I spondylolisthesis was present also. Faulong [550] has pointed out the existence of traumatic spondylolysis and called attention to the necessity of obtaining clear roentgenograms, including the oblique views.

Meschan [551] has reviewed his method of measuring spondylolisthesis radiographically and has studied the stability of the spine in cases of spondylolisthesis. If routine anteroposterior, lateral and oblique roentgenograms indicate the presence of an isthmus defect, additional lateral views are made with the spine in flexed, neutral and hyperextended positions and with the patient standing. In the roentgenograms of 520 spines the author found 61 defects of the neural arch; two thirds of these were bilateral. Of the 42 patients with bilateral defects, 62 per cent were thought to have spondylolisthesis, 19 per cent were considered "borderline," and 19 per cent showed no spondylolisthesis. By analyzing the various lateral roentgenograms Meschan was able to demonstrate instability in 14 of 26 cases of spondylolisthesis. No instability could be demonstrated in the patients with borderline defects or in persons with isthmus defects without spondylolisthesis. Correlation between instability and clinical symptoms was not attempted in these reports.

Gallucio,[552] in a study of the roentgenograms of 811 backs, found that 8.5 per cent showed spondylolysis or spondylolisthesis. He thinks that the incidence may be greater than this, since some of the roentgenographic examinations were incomplete. He recommends the use of

548. McMaster, P. E., and Dula, F. M.: Prespondylolisthesis: Twenty-Three Cases, U. S. Nav. M. Bull. **46**:1077-1082 (July) 1946.

549. Meyerding, H. W., and Flashman, F. L.: Backache (Due to Defects of Isthmic Zone of Vertebrae), J. A. M. A. **130**:75-78 (Jan. 12) 1946.

550. Faulong, L.: Frequency of Traumatic Spondylolyses with Unperceived Spondylolisthesis: Diagnostic Difficulty; Cases, Rev. du rhum. **13**:8-11 (Jan.) 1946.

551. Meschan, I.: Radiographic Analysis of Spondylolisthesis, M. J. Australia **1**:465-469 (April 6) 1946; Radiographic Study of Spondylolisthesis, with Reference to Stability Determination, Radiology **47**:249-262 (Sept.) 1946.

552. Gallucio, A. C.: Spondylolisthesis: Further Remarks with Emphasis on Radiologic Aspects, Radiology **46**:356-363 (April) 1946.

six views: routine anteroposterior, 35 degree anteroposterior, right oblique, left oblique, routine lateral and upright lateral. Garland and Thomas,[553] in a study of military personnel, report that in 10 per cent of the cases pain in the lower part of the back is attributable to spondylolisthesis. On the basis of roentgen studies, Roche and Bryan [554] have discussed various morphologic types of spondylolysis and spondylolisthesis.

Cabras [555] has reviewed the subject of spondylolisthesis, presented 10 cases and expressed his preference for nonsurgical treatment. Guri [556] has reported that 41 per cent of 34 patients with painful spondylolisthesis were relieved of their symptoms by nonsurgical treatment, 35 per cent were partially relieved and 24 per cent obtained no relief. He reports that good results were obtained in 69 per cent of a corresponding series of patients who were treated by arthrodesis. Spray and Ghormley [557] have described the excellent result eight years after arthrodesis in a patient who had been a paratrooper and had made several jumps without difficulty. Stone [558] has reported a case of spondylolisthesis treated by arthrodesis with metallic internal fixation.

## XII. CONDITIONS INVOLVING THE ELBOW, THE FOREARM, THE WRIST AND THE HAND

Prepared by

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*Surgical Anatomy.*—Murphey, Kirklin and Finlayson [559] reported a study of the anomalous innervation of the intrinsic muscles of the hand. They stressed the old conception that motion of a part is of little value in the evaluation of the function of the intrinsic muscles and that it is

553. Garland, L. H., and Thomas, S. F.: Spondylolisthesis: Criteria for More Accurate Diagnosis of True Anterior Slip of Involved Vertebral Segment, Am. J. Roentgenol. **55**:275-291 (March) 1946.

554. Roche, M. B., and Bryan, C. S.: Spondylolisthesis: Additional Variations in Anomalies in Pars Interarticularis, Arch. Surg. **53**:675-682 (Dec.) 1946.

555. Cabras, G.: Spondylolisthesis, Chir. d. org. di movimento **30**:57-89 (Jan.-March) 1946.

556. Guri, J. P.: Treatment of Painful Spondylolisthesis, Surg., Gynec. & Obst. **83**:797-806 (Dec.) 1946.

557. Spray, P. E., and Ghormley, R. K.: Results in Case of Spondylolisthesis Eight Years After Spinal Fusion, Proc. Staff Meet., Mayo Clin. **21**:150-151 (April 3) 1946.

558. Stone, M. M.: Spondylolisthesis, Fusion with Internal Metal Fixation: Case, Cir. orthop. y traumatol., Habana **12**:183-188 (Oct.-Dec.) 1945.

559. Murphey, F.; Kirklin, J. W., and Finlayson, A. I.: Anomalous Innervation of Intrinsic Muscles of Hand, Surg., Gynec. & Obst. **83**:15-23 (July) 1946.

important that the belly of the muscle be palpated to determine function. The function of various muscles which are amenable to accurate testing is given, each muscle being considered individually. An extensive study of anomalous innervation is presented.

Four cases were presented in which the first dorsal interosseous muscle was innervated by the median nerve. A total of 698 cases of ulnar nerve injury were encountered. An excellent and complete discussion of the anomalous cases is given which stresses the importance of testing the interosseous muscles of the hand in the accurate assessment of peripheral nerve injuries.

A study of innervation of the flexor digitorium profundus and the lumbrical muscles was reported by Sunderland.[560] This study was made to determine whether any relationship existed between the nerve supply of the lumbrical muscles and the nerve supply of the flexor digitorum profundus, with which it is associated. He concluded that the nerve supply of the lumbrical muscle is not necessarily the same as that of the fibers of the flexor profundus controlling the tendon and digit with which the lumbrical muscle is associated. The parts of the flexor mass supplied by the median and ulnar nerves and the relationships existing between them were also investigated and described. A further article by Sunderland[561] in regard to innervation of the first dorsal interosseous muscle states that in 100 dissections three muscles were found to be entirely innervated by the median nerve and another to be partially innervated by the median nerve. In 1 case a superficial radial nerve gave a terminal branch to the right first dorsal interosseous muscle. From clinical observation, he states that in 5 of 41 cases median nerve supply to the first dorsal interosseous muscle was demonstrated.

He discussed a statement by McKenzie which claims that the first dorsal interosseous has no flexor control on the proximal joint but extends the distal two joints. The lumbricales flex the proximal joint and exert no action on the distal two joints.

A further analysis of the relationship of the extensor digitorum communis tendon to the metacarpophalangeal joint is made by Kaplan.[562] He discusses the work of Duchenne, who in his analysis of the component parts responsible for the harmonious action of the common extensor muscle and the intrinsic muscles of the hand emphasizes the

560. Sunderland, S.: Innervation of Flexor Digitorum Profundus and Lumbrical Muscles, Anat. Rec. **93**:317-321 (Dec.) 1945.

561. Sunderland, S.: Innervation of First Dorsal Interosseous Muscle of Hand, Anat. Rec. **95**:7-10 (May) 1946.

562. Kaplan, E. B.: Relation of Extensor Digitorum Communis Tendon to Metacarpophalangeal Joint, Bull. Hosp. Joint Dis. **6**:149-154 (Oct.) 1945.

great importance of a special insertion of the extensor communis tendon to the base of the proximal phalanx.

The author of this article is among those who had found the insertion important and constant (1939), but after observation and the accumulation of more material noticed that in some fingers the special insertion did not exist. This prompted a resumption of the study with the purpose of establishing more accurately the nature of the special insertion, its incidence and its functional significance. He concludes that the arrangement of the extensor tendon over the metacarpophalangeal joint is functionally essential because it contributes the following important factors: (1) extension and hyperextension of the proximal phalanx, which permits the interosseous-lumbrical unit to extend the two distal phalanges and (2) stabilization of the metacarpophalangeal joint when the finger is in extension.

Ghigi [563] presents a study of the carpal scaphoid bone and describes in detail the location and shape of the scaphoid and its particular mechanical and internal structure. He feels that the bone has the same function in the wrist as the astragalus has in the foot. Its location explains the frequency of fracture, as any forceful stimuli from wrist to forearm or vice versa pass through it. The scaphoid, because of its construction, has a tendency to break into two fragments, the structure being least strong in the middle third.

Pomeranz [564] thinks that the supracondylar process, or the spur, is possibly a vestigial remnant of what was a bony bridge serving to protect the blood vessels and the nerve which pass through it. It is generally described as a small, composite bony projection on the medial and anterior surfaces of the humerus, about 6.5 cm. above the lower articular margin. The process is broad at the point of origin and tapers to a relatively sharp end. Its long axis is crescentic, with the convexity directed medially. The cortex of the humerus, where it arises, is unaltered. A phylogenetic variant is found in lower species of mammals, reptiles and amphibians. Clinically, this process appears to be without significance, and it is usually discovered accidentally in the course of routine examinations of the elbow joint.

An interesting study on the conditions just described was made by Barnard and McCoy.[565] They state that it appears in about 1 per cent

563. Ghigi, C.: Contributo allo studio dell'anatomia topografica della Meccanica articolare e della contituzione interna dell'osso navicolare, Chir. d. org. di movimento **30**:106-116 (Jan.-March) 1946.

564. Pomeranz, M. M.: Radiographic Vignettes: Supracondylar Process, Bull. Hosp. Joint Dis. **6**:80-81 (Oct.) 1945.

565. Barnard, L. B., and McCoy, S. M.: Supracondyloid Process of Humerus, J. Bone & Joint Surg. **28**:845-850 (Oct.) 1946.

of persons of European ancestry. Three cases are presented, in 2 of which the symptoms involved the median nerve. They are of the opinion that the median nerve passes beneath the spur, producing pressure. Surgical excision in 1 case resulted in immediate relief of the pain in the median nerve.

A method of assessment of skeletal development of the hand is presented by Michelson.[566] He states that the study is still in an experimental stage and is most difficult in the age group in which the appearance of ossification centers cannot be used as landmarks. He has formulated a criterion which involves twenty-two consecutive stages. The bone length is actually considered as a separate entity in order not to confuse the increase in the longitudinal dimension with the morphologic criterion of malnutrition. The growth factors are determined by measuring the diaphysis and epiphysis and by the calcification connecting them.

The classification of the consecutive stages of development of the hand skeleton, including twenty-one stages, is presented, and the findings in each stage are revealed.

*Surface Covering.*—As a result of World War II, considerable work was done on the covering of surfaces of the hands. A rather extensive and complete article is presented by Webster and Rowland.[567] A review of the types and methods of skin grafting on the dorsum of the hand to replace loss of skin from severe burns is presented.

They have a new classification which divides the old "three degrees" into subgroups, first degree burns being divided into two groups, second degree burns into three groups and third degree burns into three groups. The subdivision has to do with the injury together with the clinical appearance in relation to the time interval following the burn.

A plea is made for early grafting whenever possible and for treatment directed toward early closure of the wound. The fundamental principles of cleanliness and compression are emphasized as well as the general care of the patient and the use of chemotherapy. The problems of the choice of method of grafting and of the so-called "temporary grafting" and the indications for such are discussed. The temporary graft is one that is put on primarily for closure with the knowledge that later a more extensive type of procedure will be necessary. The prevention of contractures and the placing of the fingers in a position of function are stressed. The importance of irregular borders of the grafts to prevent contractures and of the control of the recurring web formation between the fingers is brought out.

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566. Michelson, N.: Method for Assessing Development of Hand Skeleton, Am. J. Phys. Anthropol. **4**:235-242 (June) 1946.

567. Webster, G. V., and Rowland, W. D.: Skin-Grafting Burned Dorsum of Hand, Ann. Surg. **124**:449-462 (Aug.) 1946.

A portion of the article is devoted to the unsolved problems which include the deformity of the nails, loss of the extensor tendon mechanism on the dorsum of the fingers, the circulation of the hand secondary to constrictions and the pigmentation of the skin after grafting.

Another extensive presentation covering the repair of surface defects of the upper extremities is presented by Shaw and Payne.[568] It is their opinion that wounds should be closed early with split grafts or by secondary suturing of wounds. The importance of pressure to prevent edema is stressed. They state that early nerve sutures as well as joint mobilization should be carried out whenever possible. The damaged muscles should be supported by splinting. When defects are deep, a transplantation of subcutaneous tissue as well as surface covering is necessary and should be done after excision of the deep scar and the diseased tissue. They stress the fact that incisions and graft margin should not cross flexor creases and suggest that contractures can be benefited by traction during and after scar excision. Local skin flaps are not desirable for filling defects of the finger because of limited skin.

The surgical principles presented by the authors include the excision of the deep scar at the time of the flap and the importance of eliminating any dead space and foreign material. They express the belief that local flaps are better for small defects as they maintain and carry some sensation. Double pedicle flaps are not desirable, and they prefer a single pedicle flap, with primary closure of the defect done in a single stage.

Rubin[569] writes that primary flaps are indicated in cases in which there is exposure of bone and tendon. He states that an abdominal flap may have a length up to three times its width but that the pedicle or graft should not cross the midline. A loose pedicle is important to avoid pull on the graft when the hand is placed on the abdomen. When there is a question of circulation, a few days' delay is indicated. His operative technic is described rather fully; the anesthetic of choice is brachial block, with local infiltration of the abdominal flap.

A number of cases are presented in which the various technics advocated are employed. He states that in 49 cases of flap graft closures were done, with good functional result. An early covering of exposed and infected tendons and bone with the use of the above technic is advocated.

[ED. NOTE.—I question the desirability of covering infected areas with skin flaps.]

An excellent article on early covering of traumatic deformities of the foot and hand encountered in civilian practice is presented by

568. Shaw, D. T., and Payne, R. L., Jr.: Repair of Surface Defects of Upper Extremity, Tr. South. S. A. (1945) **57**:243-268, 1946.

569. Rubin, L. R.: Repair of Avulsion Wounds of Hands and Feet by Flap Graft Technic, Am. J. Surg. **72**:373-384 (Sept.) 1946.

McDonald and Webster.[570] The early closure of a wound should be considered a fundamental surgical principle. When it is impractical to close a wound immediately, primary healing can still be obtained in many instances by secondary closure within a period of a few days. The penalty of neglecting to close open wounds of the hands early is frequently permanent and costly. This point was illustrated by presentation of a case in which a large granulated area resulted which required extensive surgical treatment to close. The authors express the desirability of immediate flaps when it is impossible to close with split thickness grafts.

If there is a question of viability of tissue or if the patient has other serious injuries, a period of four or five days may elapse before surgical closure. The article is well illustrated, the proper technic of raising and managing pedicle flaps being shown.

An extensive article on the treatment of injuries and burns of the hand is presented by Hardy.[571] The author has his own classification of hand injuries, which is as follows: (1) burn, (2) contracture of all varieties, (3) traumatic amputation of the digits, (4) lacerated tendons, (5) postinfectious deformities and (6) multiple injuries involving tendons, nerves and bone.

A short discussion on each of the subheadings is given. A number of cases are presented which illustrate the various types of treatment, including split thickness skin grafts, distant pedicle grafts and flexor tendon grafts. He states that the cooperation of the patient is needed to obtain good results.

*Infections.*—The new method of treating suppurative tenosynovitis in the fingers was presented by Burt.[572] This consisted of making more conservative incisions which included one over each of the proximal two phalanges either on the same side or on opposite sides. Penicillin was injected into the tendon sheath as well as being given intramuscularly. The method was described in detail and cases were presented.

Marsden[573] reported 10 cases in which penicillin had been used locally for suppurative tenosynovitis of the hand.

With the patient under general anesthesia, the hand was surgically prepared, and with a tenotone two small transverse incisions were made

570. McDonald, J. J., and Webster, J. P.: Early Covering of Extensive Traumatic Deformities of Hand and Foot, Plast. & Reconstruct. Surg. **1**:49-57 (July) 1946.

571. Hardy, S. B.: Rehabilitation of Injured Hand, Am. J. Surg. **72**:352-362 (Sept.) 1946.

572. Burt, L. E.: Treatment of Suppurative Tenosynovitis in Fingers, M. J. Australia **1**:399 (March 23) 1946.

573. Marsden, J. A.: Penicillin Therapy for Tendon Sheath Infections of Hand, M. J. Australia **1**:435-436 (March 30) 1946.

into the flexor sheath. Two needles were placed through the incisions, and the penicillin was washed through the tendon sheath. These injections, were repeated daily, and penicillin was given intramuscularly at two to four hour intervals.

In another article on infections of the hand, Newton [574] presented several cases—1 of a soft tissue infection of the distal phalanx, 2 of infections of the web or the commissural space and 3 of suppurative tenosynovitis of the flexor tendon sheath. He stresses the importance of adequate surgical drainage and gives an illustration of the type of incision which he uses. The incision is longitudinal and crosses the distal palmar crease of the hand. He is of the opinion that this gives more adequate drainage than the transverse incision.

[ED. NOTE.—I doubt the advisability of extending the incision across the flexor crease.]

An excellent and extensive article on the general consideration of infections of the hand was presented by Requarth.[575] It is the author's feeling that in cases of acute cellulitis the hand should not be opened within twenty-four hours, that period being used for wet packing while localization is being awaited. The surgical procedure is done under general anesthesia, with a tourniquet to control bleeding.

Requarth discusses the proper incision to prevent contractures. The so-called fish-mouth incision should not be used in an operation for a felon. For the treatment of aronychia, he advocates a longitudinal incision into the side of the nail; the skin is retracted over the base of the nail and the undermined portion cut away. In the collar button type of abscess, the incision is made proximal to the web and parallel to the distal palmar crease.

An extensive discussion is presented on infections of the flexor tendon sheath and on the type of drainage indicated. The treatment of infections of the subcutaneous and subaponeurotic spaces is entirely covered, as well as the seriousness of the human bite of the hand.

Moses [576] presents two articles on early and differential diagnosis of infections of the hand. The first article deals with differentiation of soft tissue infections of the finger from tenosynovitis. He tests by resisting flexion of the finger, which he does by catching beneath the tip of the finger nail. The resistance on the finger nail prevents pressure at the site of the inflammation and thus helps to localize the infection as pressure pain is eliminated. In cases of soft tissue infections the pain

574. Newton, N. G.: Serious Infections of Hand and Penicillin, M. J. Australia **2**:129-131 (July 27) 1946.

575. Requarth, W. H.: Diagnosis and Treatment of Localized Infections in Hand, U. S. Nav. M. Bull. **46**:1354-1367 (Sept.) 1946.

576. Moses, W. R.: Diagnosis of Acute Flexor Tendon Tenosynovitis, Surg., Gynec. & Obst. **82**:101 (Jan.) 1946.

will not be increased, but in cases of tendon infection there will be considerable increase of pain, which will extend along the palmar aspect of the finger because of the bow string of the tendon against the sheath. The second article [577] deals with the diagnosis of abscess of the thenar space. The author states the belief that there is a significant limitation of components controlled by the adductor pollicis muscle in abscesses of the thenar space. He advocates early drainage and presents a test which he considers will aid in the early diagnosis.

The test consists of putting the adductor muscle of the thumb under tension. In the performance of the test, the hand is put flat on the table and an object such as a match is put between the abducted thumb and the index finger. In the attempt to adduct, it will put pressure on the pus if any is present and produce considerable pain. The diagnosis made by means of this test has been proved in 6 cases by operative findings.

*Acute Injuries of the Tendon.*—A study of 32 cases of lacerated tendons of the hand was presented by Hertzberg.[578] The flexor tendon was cut in 5 cases and the extensor in 27. Nine of the extensor injuries were complicated by other damage. The author advocates a limit of six hours for primary suturing of extensor tendons and two hours for that of flexor tendons. He feels that when the wound heals by primary intention secondary suturing can be carried out within one month. For infected wounds, he waits from six months to a year and a half, depending on the duration of infection.

Tendon sutures are contraindicated in the following instances: (1) when the tendon is not totally divided, (2) when only one of the two extensor tendons is divided, (3) when the extensor tendon is injured at the insertion in the distal phalanx, (4) when only the superficial flexor is cut, (5) when only the deep flexor tendon is cut (suturing should be done only when conditions are good) and (6) when both flexor tendons are cut (only the deep one should be sutured).

A review of cases is presented.

Ledergerber [579] presented what he considers a simpler method of treatment of avulsion of the extensor tendon of the finger. He utilizes the finger nail as an aid to splinting, two holes being put through the portion of the nail which protrudes beyond the tip of the finger. A dorsal splint is fixed to the nail with a suture, the splint being padded

577. Moses, W. R.: Diagnosis of Thenar Space Abscess, Am. J. Surg. **72:** 583-584 (Oct.) 1946.

578. Hertzberg, J.: Treatment of Injuries of Tendons of Hand, Nord. med. **31:**1893-1897 (Aug. 23) 1946.

579. Ledergerber, E.: Ein Beitrag zur unblutigen Behandlung des Strecksehnenabrisses der Finger, Schweiz. med. Wchnschr. **75:**1088-1089 (Dec. 8) 1945.

by gauze over the distal joint and the remainder of the splint fixed with adhesive tape. He advocates splinting for a period of six weeks.

The disadvantage of plaster fixation is discussed by Schaubel and Smith.[580] A splint is described as constructed from a tongue blade, with a piece of cork glued to it to maintain hyperextension of the distal joint.

*General Consideration of Treatment of Injuries of the Hand.*—There were many well written and well presented general articles dealing with injuries of the hand. Cleveland [581] states that in 72 per cent of patients with war injuries who survived to reach military hospitals the extremities were involved. In two fifths of the cases the upper extremities were injured. The problem of immediate care of wounds on the hands is frequently complicated by multiple wounds on other portions of the body. Often the wound in the hand is neglected because lifesaving measures are necessary.

A general discussion on the necessity of adequate and proper treatment to save what is left of an injured hand is given. The author advocates early closure of the wound when possible, as an intact integument is essential to save damaged nerves, tendons and bones. Nerves and tendons should be repaired primarily if possible. The fractures should be considered secondarily to soft tissue injuries in most instances. Skeletal traction is advocated in preference to so-called pulp traction.

Early roentgen studies of injuries of the wrist will often locate fractures of the carpal scaphoid. Immobilization in plaster of paris should not include portions of the hand not involved in the injury. The role of physical therapy and the restoration of the hand are discussed.

A general survey of army methods of handling war injuries of the hand is presented by Bruner.[582] He comments on the early closure of wounds in foreign theaters and stresses the importance of correct splinting, physical therapy and occupational therapy in rehabilitation. The special procedure necessary for treating injuries of the skin, nerve, bone, joint and tendon is discussed.

Many more extensive procedures, such as shifting of fingers and pollicization, are commented on.

After a discussion of treatment for septic infections of the hands and fingers, the indications for conservative and radical surgical intervention

580. Schaubel, H. J., and Smith, E. W.: Splint for Treatment of Mallet Finger, J. Bone & Joint Surg. **28**:394-395 (April) 1946.

581. Cleveland, M.: Saving the Injured Hand, New York Med. **2**:19-22 (Sept. 5) 1946.

582. Bruner, J. M.: Treatment of War Injuries of Hand in U. S. Army, J. Iowa M. Soc. **36**:509-511 (Dec.) 1946.

in these regions are presented by Stonham.[583] The technic for amputation of a finger is described. In the presence of infection, disarticulation is preferable to section of the bone. The observations pertain especially to war wounds.

A simple method for extracting fish hooks is described, in which the hook, guided by a scalpel blade, is drawn out through the passage of entrance. Sepsis often develops and must be watched for so that early chemotherapy can be instituted. In cases of diphtheroid infection the author administers antitoxin and applies bismuth iodoform paraffin paste or actual cautery.

For burns of the fingers and hand, the author has found tanning to give good results. In severe cases various methods for grafting may be used.

[ED. NOTE.—The advisability of tanning in cases of burns involving flexor or extensor creases is questionable.]

Mason [584] presents a rather comprehensive article on the subject of primary and secondary repair of nerves and tendons. The first principle stressed is that of protection against further trauma and the second that of protection against contamination of the wound, soap and water cleansing of the skin and closure of the wounds to prevent further contamination. He advocates the use of a prepared metal splint which conforms to the configuration of the hand. He gives a four hour limit for primary closure in repair of tendons and a six to eight hour limit for closure in repair of nerves. He feels that it is unwise to suture beneath flaps or grafts. Secondary repairs should be done only after all induration is gone. He is not in favor of putting in artificial membranes to form sheaths or to replace tendons.

Koch [585] divides the treatment of tendons and nerves of the hand into that given immediately after injury and that given after healing of the wound is complete. If primary suturing is to be done, the condition must be satisfactory so that primary healing will occur. Secondly, whether or not the repair is early or late anatomic restoration is of great importance. It is far better to err on the conservative side than to attempt to do too much. It is felt that the local medication is detrimental to primary healing of the tendon. A few points of the technic of suturing the nerves and tendons are presented. When the tendon is frozen in a digital sheath, there is no adequate method of repair or freeing. A complete tendon graft is necessary. The use of a plasma clot in repair

583. Stonham, F. V.: Some Observations on Surgery of Hand, Indian M. Gaz. **80**:597-601 (Dec.) 1945.

584. Mason, M. L.: Injuries to Hand, with Particular Reference to Indications for Primary and Secondary Nerve and Tendon Repair, J. Oklahoma M. A. **39**:246-251 (June) 1946.

585. Koch, S. L.: Injuries of Nerves and Tendons of Hand, Cincinnati J. Med. **27**:515-521 (Aug.) 1946.

of nerves is discussed, and it is the author's belief that it is not satisfactory, particularly in the cases of secondary healing.

In regard to gliding materials in tendon work, it is believed that gelatin, cellophane or amniotic fluid have little or no value. The ideal gliding material is soft areolar tissue. The importance of not having tension on the tendon and nerve sutures is stressed.

An extensive article on the general consideration and treatment of injuries of the hand and on the reconstructive surgical procedures and the general principles necessary for restoration of the function of the hand is presented by Moore.[586] The importance of a detailed original examination and of follow-up care is stressed. The type of treatment is influenced by the occupation of the patient.

There must be a complete and adequate skin covering and complete mobilization of joints before reconstructive surgical treatment is instituted. The author contends that arthroplasty and other procedures should not be combined with repairs of tendons. Repair of a tendon should be done prior to point surgical intervention on the joint. He advises the use of dorsal splints for repair of volar tendons and the use of volar splints for repair of dorsal tendons; the splinting should not include portions of the hands not undergoing operative procedure. The importance of detailed occupational therapy is stressed. He enumerates a number of mistakes made in the surgical treatment of the hand, which include (1) prolonged immobilization, (2) forceful manipulation under anesthesia, (3) allowing exposed areas to heal by granulation, (4) failure to operate with a tourniquet and (5) failure to have adequate tools to perform the delicate operation indicated.

He feels that a finger with stiff joints and with injuries to the nerves and tendons is an indication for amputation and not for reconstruction.

A number of cases in which there was severe damage to the bones of the hand are presented by Snedecor.[587] A general discussion of various possibilities of reconstruction is presented. He prefers fixation of bone grafts with Kirschner's wires.

A case in which total carpectomy was carried out for release of Volkmann's contracture is presented.

A general written discussion regarding traumatic lesions of the hand is presented by Gonzalez Garcia.[588] He stresses the need for immediate

586. Moore, F. T.: Discussion on Treatment of Injuries to Hand, Brit. J. Surg. **34**:70-74 (July) 1946.

587. Snedecor, S. T.: Bone Surgery of Hand, Am. J. Surg. **72**:363-372 (Sept.) 1946.

588. Gonzalez Garcia, A.: Estadisticas traumatologicas, J. Internat. Coll. Surgeons **9**:506-508 (July-Aug.) 1946.

early care and observes that the left hand is more often injured than the right, particularly in workers on sugar cane plantations.

*Stenosing Tenosynovitis and Tendinitis.*—Rose [589] presents 2 cases of so-called trigger thumb in infants aged 9 months and 2 years respectively. In a general discussion he states that the lesion is first localized in the tendon sheath and that the changes in the tendon are secondary. The pathologic process is similar to that in adults.

His patients are treated by incision of the sheath to relieve the constriction. Prognosis is considered good, and recurrence is rare. The condition may be present from birth, and a small movable swelling appears at the base of the thumb. In the case reported the nodules on the tendon did not decrease in size.

Lasserre [590] has changed the name of "trigger finger" to that of "spring finger," and he presents a simple method of preventing the finger from snapping into complete flexion. He has devised a ring with the signate part anterior for the purpose of preventing the finger from going into complete flexion. He states that this gives sufficient block to the finger to prevent the nodule on the tendon from passing beneath the arc of the digital sheath. This simple method is indicated before surgical intervention.

An interesting article on calcareous tendinitis of the flexor tendon of a finger is presented by Vasko.[591] In a general discussion he states that calcification takes place in various tendon tissues of the body. The etiology is still uncertain. Some authors feel that it is due to trauma and others that it is a metabolic disturbance and is due to a deficiency of vitamin E. Treatment of such calcifications varies, surgical removal, diathermy, administration of salicylates, roentgen therapy, irrigation, injections of procaine hydrochloride or the administration of vitamin E being employed.

A case is reported in which the right middle finger of a 28 year old man was involved. The onset was gradual. The roentgenogram revealed considerable saucer-shaped calcifications lying in the soft tissue anterior and proximal to the distal interphalangeal joint. There was a spontaneous disappearance of the calcifications, swelling and pain. The only treatment employed was splinting.

A case of a 38 year old woman with radial palsy as a result of a gunshot wound is presented by Poinot.[592] An attempt at nerve suture resulted in secondary suppuration and failure.

589. Rose, T. F.: Bilateral Trigger Thumb in Infants, M. J. Australia **1**:18-20 (Jan. 5) 1946.

590. Lasserre, C.: Un traitement simple du doigt à ressort, J. de méd. de Bordeaux **121-122**:375-376 (July) 1945.

591. Vasko, J. R.: Calcareous Tendinitis of Flexor Tendon of Finger: Report of Case, J. Bone & Joint Surg. **28**:638-640 (July) 1946.

592. Poinot, J.: Paralysie radiale, tenoplastie des extenseurs, Bordeaux chir. **3-4**:148-149 (July-Oct.) 1945.

Eight months after injury transplantation of the flexors of the wrist and the palmaris longus to replace the extensors of fingers and wrist was done, the palmaris longus being used to extend the thumb. The hand was splinted in extension for twenty days. Eight months after surgical treatment the patient had normal extension of all fingers.

The author states that a similar operation was performed in 3 other cases, with excellent results.

A similar case of radial palsy was reported by Charbonnel and Barroux.[593] In this case the palmaris longus, as well as the wrist flexors, was transplanted. Splinting for a period of four months was carried out. The patient apparently had suffered considerable other damage to the nerves. No final analysis of the case was presented.

An excellent and extensive article by Zachary [594] on a follow-up of transplants for radial paralysis is presented. According to this author, the persistent assertion in the papers reviewed that failures were due to defective postoperative care strongly suggests that failures are by no means uncommon. Because of this, a review of the cases at the Winfield Morris Hospital from 1940 to 1945 was undertaken. Fifty-seven cases were reviewed, and a rather critical analysis of results was made.

The author worked out a system whereby a loss of each 10 degrees of extension of the fingers was rated as a negative 10 per cent. Flexion and extension of the wrist were also put on a percentage basis. He presented an extensive table of individual cases classified according to the transplant and the result. In transplants for radial paralysis, it is important to preserve active flexion to stabilize the wrist, and failure to take this precaution often leads to incomplete extension of the fingers and unnecessarily weakens or abolishes the power of the wrist flexor. He advocates leaving the flexor carpi radialis to flex the wrist.

A standard method for testing the result of tendon transplant for radial paralysis is suggested and illustrated.

Guilleminet and Dubost [595] present a case of severe obstetric paralysis with the classic deformity of internal rotation and radial paralysis. The problem considered was that of correcting the position of internal rotation and wrist drop to restore adequate digital extension. A rotation osteotomy was done, followed by a transplantation of the flexors of the wrist to extend the fingers and wrist. An extensive discussion of the case and of other possibilities is given by the author.

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593. Charbonnel and Barroux, R.: Transplantations tendineuses pour paralysie radiale définitive, Bordeaux chir. **1-2**:55 (Jan.-April) 1944.

594. Zachary, R. B.: Tendon-Transplantation for Radial Paralysis, Brit. J. Surg. **33**:358-364 (April) 1946.

595. Guilleminet, M., and Dubost, T.: Un cas de traitement de la paralysie des extenseurs des doigts et de la main par transplantation tendineuse chez un enfant de cinq ans, Rev. d'orthop. **32**:72-75 (Jan.-April) 1946.

Five cases of rupture of the extensor pollicis longus tendon following Colles' fracture are presented by Smith.[596] In a review of the literature presented, he states that the first case was reported by Duplay in 1876. He considers the condition to be due to injury of the tendon by a spicule of bone or to chronic tenosynovitis possibly interfering with the blood supply. Often there are no preliminary symptoms, and the first finding is the drooping of the thumb. The site of the rupture is usually at Lister's tubercle. The average time from the fracture to the time of rupture is twenty-nine days.

The dual function of the extensor pollicis longus is discussed. The author holds that the extensor function is less important than the prevention of the droop by the oblique pull of the tendon on the thumb. The direction of pull is extremely important. The method of repair effected is that of suturing the extensor pollicis longus to the extensor carpi radialis longus. The extensor pollicis brevis is also sutured to the distal stump in a side to side manner.

A case of bilateral ruptured extensor pollicis longus tendon is presented by Jorgensen.[597] The patient was a man, 33 years old, who was suffering from diabetes mellitus which was well under control. With no history of trauma, there developed on both wrists an inflammatory degenerative process at the site of predilection for rupture of the extensor pollicis longus. After a few years, a bilateral rupture occurred, one side being treated surgically.

In his report, May[598] states that tendon transplantation is the free grafting of a tendon for the purpose of filling a tendon defect or replacing a destroyed tendon. If the defect is due to infection, a delay of three months, with the use of penicillin, is necessary. The author favors removal of the paratenon with the tendon to be transplanted. This aids in the early activation of the tendon. He stresses the point that a stiff joint is a strict contraindication to any repair of the tendon unless mobilization is possible by physical therapy or operative manipulation.

He prefers operating in a bloodless field and describes incisions which are more or less accepted at the present time. He feels that a primary tendon suture should be attempted only in the most favorable circumstances, that primary sutures should not be done as a rule and that a secondary graft is usually indicated. If both flexors of the tendons of the finger are cut, only the profundus is sutured.

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596. Smith, F. M.: Late Rupture of Extensor Pollicis Longus Tendon Following Colles's Fracture, J. Bone & Joint Surg. **28**:49-59 (Jan.) 1946.

597. Jorgensen, G.: Case of Bilateral Spontaneous Rupture of Extensor Pollicis Longus Tendon, Ugesk. f. læger **107**:506-507 (June 28) 1945.

598. May, H.: Tendon Transplantation in Hand, Surg., Gynec. & Obst. **83**: 631-638 (Nov.) 1946.

The author presents a new splint, which appears to be satisfactory, for the immobilization of individual joints.

A case of a patient, 40 years old, who suffered a dislocation of the tendon of the extensor carpi ulnaris muscle is presented by Obrant.[599] Examination revealed a dislocation of the tendon on the ulnar volar aspect. The tendon sheath here formed a sac, which was incised, and its volar and dorsal margins were sutured to bring the sheath to normal position. The hand was then immobilized in slight flexion. After twelve days exercises were begun, and two weeks later the patient was discharged in good condition.

[ED. NOTE.—Two weeks is not sufficient time for tendons and ligaments to heal sufficiently to withstand stress.]

Webster [600] describes the reason for poor results of the primary tendon suture as being anatomic, bacterial and surgical. The benefit of the "straight-line" pull of the extensor tendon over the metacarpals and of a "straight-line" pull of the flexor tendon to the wrist and palm of the hand is stressed. The "around the corner pull" of the flexors of the finger is mentioned as well as the fact that the flexor tendon necessarily passes through the synovial sheath and tunnel which resists the normal gliding of the tendon. The necessity of adequate surgical technic to prevent bacterial introduction is also brought out. The errors of improper and poor surgical technic and judgment and of the improper incision which leads to failure are stressed. The author mentions that tendons with stiffness of the distal joints should not be repaired.

A general discussion on the various problems and the after-care through the period of immobilization is presented. It is also stressed that cooperation of the patient must be excellent if good results are to be obtained. Good results are frequent, but excellent results are rare.

Kestler [601] reported a case in which there was recurrent dislocation of the first carpometacarpal joint. An operative procedure was described which consisted of taking the extensor pollicis brevis distal to the dislocated joint and transplanting it through the holes in the first metacarpal and greater multangular bones. The capsule was then closed and the distal portion of the tendon sutured back to the proximal end of the tendon. It is the author's contention that function of the muscles is adequate to hold the involved bone in place.

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599. Obrant, O.: Case of Dislocation of Tendon of Extensor Carpi Ulnaris Muscle, Nord. med. **29**:656 (March 22) 1946.

600. Webster, G. V.: Late Repair of Tendons in Hand, Am. J. Surg. **72**:171-178 (Aug.) 1946.

601. Kestler, O. C.: Recurrent Dislocation of First Carpometacarpal Joint Repaired by Functional Tenodesis, J. Bone & Joint Surg. **28**:858-861 (Oct.) 1946.

A new operation for treatment of habitual dislocation of the proximal phalanx of the thumb is presented by von Stapelmohr.[602] Splendid results were obtained in 2 cases. After radial and ulnar incision at the level of the basal joint, the tendons of the abductor flexor and the adductor pollicis brevis are exposed and drawn together by a cuff of transplanted fascia lata.

*Splinting and Rehabilitation.*—Many types of extremely satisfactory splints are presented by Bunnell.[603] The article is well illustrated, and the principle of each splint is stressed.

He presents a "cock-up" splint for the wrist, various traction splints for the metacarpal joints and a so-called knuckle-bender splint which is operated by elastic traction for the metacarpophalangeal joints. Most of these splints are operated by spring or rubber band traction which aids in the correction of deformities of the fingers, wrists and hands. He presents an adequate splint for practically any condition of the hand. This is a useful article on splinting of the hand to overcome various contractures and deformities. Bunnell[604] presented another article devoted entirely to the "knuckle-bender" splint. He stresses the instances in which the splint is indicated and states that it corrects the deformity from muscle imbalance of both the median and the ulnar nerves. A discussion of the principle and the function of the splint is presented as well as a detailed method of construction. The flexion can be controlled by the number or the strength of the rubber bands.

A splint to correct and prevent deformity in paralysis of the ulnar nerves is presented by Pruce.[605] The splint is made with a soft leather cuff which circles the proximal phalanges and is attached to a leather wristlet by a rubber band. It is left in place until there is either full recovery or no hope for further improvement. It is of no value in established claw deformity with secondary contracture of the joints and is useless in cases in which there is a broken transverse metacarpal arch of involved digits. Further observation is needed for final evaluation.

Lefkoe[606] states that injuries of the hand and fingers are beginning to assume their true importance in the surgeon's vista. In 1941, 77 per cent of all permanent impairments in the field of manufacturing involved

602. von Stapelmohr, S.: Operation for Habitual Luxation of Thumb, Acta chir. Scandinav. **94**:379-382, 1946.

603. Bunnell, S.: Active Splinting of Hand, J. Bone & Joint Surg. **28**:732-736 (Oct.) 1946.

604. Bunnell, S.: Knuckle Bender Splint, Bull. U. S. Army M. Dept. **5**:230-231 (Feb.) 1946.

605. Pruce, A. M.: Splint to Correct Deformity Resulting from Injury to Ulnar Nerve, J. Bone & Joint Surg. **28**:397 (April) 1946.

606. Lefkoe, H.: Rapid Rehabilitation Following Hand Injuries, Arch. Phys. Med. **27**:499-508 (Aug.) 1946.

the hand. He discusses the point that surgical treatment of the hand is no longer considered "minor surgery" but is in the "major surgery" field.

There are a tremendous number of papers covering the surgical technic of operations on the hand, but there are extremely few on the definitive surgical treatment. The author feels that physical therapy apparently includes all fields of physical medicine. He is opposed to early readaptation of the patient to his former work, as it promotes substitution by the patient.

Brachial block is considered to be the anesthesia of choice, and operations are done under tourniquet. Early closure of wounds of the hand is stressed, and the importance of the pressure dressing is brought out. Sensitive skin grafts as complications of stumps of fingers are treated with tannic acid solution to toughen the skin. Immobilization should not include parts which are not involved. The importance of early motion after fractures is emphasized, and he states that excellent anatomic position is a poor substitute for function. The importance of the use of procaine hydrochloride intravenously is stressed. He brings out that a muscle, to be transposed, should be of good power and that redevelopment of the muscle power can be obtained only by mobilization plus coordination. He stresses the importance of individual muscle training in preference to group muscle training.

A discussion of the relative merits of paraffin baths as compared with those of infra-red radial heat is given. The physiopathic syndrome of the swellers and nonswellers is attributed to a constitutional inferiority of the neurovascular system.

Pearlman [607] advocates the wrapping of adherent flexor tendons with a fine tantalum foil. After the tendon is wrapped with the foil, motion is instituted in three or four days. The tantalum is wrapped completely around the tendon, and the tendon is dropped back into the normal channel. Heavy foil is contraindicated, as it will often move and may cause pressure necrosis of the skin.

[ED. NOTE.—I question the advisability of completely surrounding the tendon with any impermeable membrane, as the tendon is kept alive by adjacent body fluids.]

*Reconstruction of the Thumb and Fingers.*—A general consideration of the methods and problems encountered in reconstruction of the thumb is presented by Greeley.[608] He states that there are four methods of physiologic reconstruction to be considered: (1) deepening of the thumb web, (2) pollicization of the remaining partial finger, (3) replace-

607. Pearlman, R. C.: Use of Tantalum in Tendon Reconstruction of the Hand, U. S. Nav. M. Bull. **46**:1647-1650 (Nov.) 1946.

608. Greeley, P. W.: Reconstruction of Thumb, Ann. Surg. **124**:60-70 (July) 1946.

ment with a toe and (4) lengthening of the missing thumb stump. Pollicization of the index finger should be reserved for persons with subtotal loss of the index finger.

The author constructed ten thumbs by forming a tube pedicle graft of skin and inserting a bone graft for the stabilizing portion. The use of tibia, iliac crest and twelfth rib was tried. A complete discussion of the technic employed is presented.

The first complication mentioned by the author was a breakdown of the pedicle at the distal end. The second complication was that of infection and necrosis of the bone graft, and the third was a green stub fracture of the graft. He states that all types of sensation except stereognosis developed in the transplanted skin flap, the time required for this varying from six months to two years.

A case is presented by Beardsley and Zecchino [609] in which a thumb is reconstructed from an abdominal flap. The reconstruction was carried out in four stages.

In the first stage a tube was formed on the abdomen and a tibial bone graft transplanted into the formed tube. In the second and third stages the tube was attached to the hand. The fourth stage consisted in dividing the pedicle and shaping the thumb. The authors felt that the cosmetic result justified the surgical procedure.

Morandi [610] reviews the literature on methods of reconstruction of the thumb and reports 15 cases. In 2 cases freezing was the cause of injury and in the remainder explosion of hand grenades and similar incidents. In 2 cases there remained a small residual stump of the thumb which was of no practical use for grasping. The effect of the type and degree of injury on function is discussed. He presents methods of phalangization.

If an attempt is made to deepen the interspace between the first and second metacarpals, one will have to await secondary healing in the proximal portion of the wound because of dearth of the skin flaps. Removal of the second and third metacarpals permits opposing skin flaps and complete closure. Functional results of phalangization following physical therapy which begins the third week after operation are excellent.

In cases in which amputation of the finger from the radial side of the hand, so common in war surgery, has been carried out, a portion of the basal phalanx of the thumb remains and removal of the second metacarpal will be found of great advantage. If the thumb is disarticulated

609. Beardsley, J. M., and Zecchino, V.: Reconstruction of Thumb, Am. J. Surg. **71**:825-827 (June) 1946.

610. Morandi, G.: Indicazioni e risultati della ricostruzione chirurgica del pollice, Chir. d. org. di movimento **30**:41-51 (Jan.-March) 1946.

to the metacarpophalangea or if the distal epiphysis of the first metacarpal is also destroyed, the second and third metacarpals should be removed, since this allows better function.

Young [611] states that the first work in transplanting toes for fingers was done by Nicoladoni. His first report was in 1900—that of the substitution of a part of the second toe for a partial defect of the thumb. In the same year Von Eiselsberg reported restoration of the index finger.

The literature on the subject was reviewed. A case is reported in which the second toe was transplanted to replace the loss of the distal portion of the index finger. The distal two phalanges of the toe were transplanted, which resulted in no motion of the distal joint, coloring and sensation having returned to the level of the nail bed.

[ED. NOTE.—It would appear that the benefit of this operation is purely cosmetic.]

Restoration of a missing thumb in 2 cases by transplantation of the index finger is reported by Kelikian and Bintcliffe.[612] In both cases there were partial damage to the index finger and loss of the thumb. The cleft between the transplanted index finger and the middle finger was formed by an abdominal pedicle flap. There was an attempt to preserve the nerve and arterial supply of the index finger as well as the function of the flexor and extensor tendons. The authors' criterion for a successfully reconstructed thumb was a thumb that would move out and in the oppositional position, abduct, flex and touch the other finger tips. It must be able to feel and to distinguish between hot and cold and to convey some awareness of shape and position.

A rather extensive report of the operative procedure is presented as well as a discussion of variations and short cuts which might be considered.

Records of 517 cases in which lost fingers or thumbs were replaced by plastic methods were collected by Parin.[613] He presented 202 of his own cases in which treatment was carried out for loss of fingers as a result of wounds, frostbite and congenital anomalies. In some reconstructive procedures were carried out, and many of his results are shown in photographs.

He states that phalangization of the first metacarpal is presented in a few cases, three to five of the metacarpals being phalangized. Pollicization of the index finger was carried out. Transplantation of the finger from the opposite hand to replace a lost thumb was also carried out, the ring finger of the opposite hand being used for the transplant.

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611. Young, F.: Transplantation of Toes for Fingers, Surgery **20**:117-123 (July) 1946.

612. Kelikian, H., and Bintcliffe, E. W.: Functional Restoration of Thumb: Pollicization of the Index, Surg., Gynec. & Obst. **83**:807-814 (Dec.) 1946.

613. Parin, B. V.: Reconstruction of Fingers, abstracted, Bull. War Med. **6**: 524 (Aug.) 1946.

In transplanting toes to the hand, the author closely followed the technic described by Nicoladoni, the second and third toes being used for the transplant. He describes a case in which four toes were transplanted simultaneously to replace fingers.

Kallio [614] states that in spite of the disability and inconvenience caused by the absence of a thumb a review of the literature does not give the impression that much attention has been given to plastic procedures for surgical corrections.

The author presents a series of 10 cases which he divides into two groups according to whether the material for plastic replacement was taken from the immediate adjacent tissues of the hand or transplanted from other parts of the body. The method of using remote flaps was applied in 5 cases. The transplanted bone in the skin tube was absorbed in 4 cases, which necessitated repeated transplantation of bone. In regard to sensibility, mobility and strength, the thumbs produced were most satisfactory. With the exception of the ends, they were sensitive to touch and pinprick, and four were even sensitive to heat.

In 1 case in which the thumb and the first metacarpal joint were missing excellent results were obtained by a means of a distant plastic procedure performed in three stages. In the second stage a free bone graft was inserted directly into the multangulum majus and, after fixation, introduced into a skin tube formed from abdominal skin at the first stage. This tube was then sutured to the hand. It is suggested that in the estimation of disability for compensation claims, this should be judged as being from 10 to 15 per cent higher when the first metacarpal is missing. Plastic operations are capable of reducing this disability by 5 to 10 per cent.

*Dislocations of Wrist.*—Martinez Correa [615] presents 7 cases of severe lesion of the distal portion of the forearm and wrist. In the majority healing was by radiocarpal ankylosis, which necessitated resection of a segment of the ulna to obtain prosupination movements. He discusses the complex physiology of these movements, including rotation of the radius around an immovable ulna and rotation by simultaneous displacement of the two bones of the forearm, which is much more complex. Total or partial loss of supination is much more important from a functional point of view than limitation or loss of pronation, which is easily compensated by pronation of the shoulder.

The 7 cases are described in detail. Radiocarpal arthritis was followed by ankylosis in 2 cases and sequestration of the distal epiphysis

614. Kallio, K. E.: Sur les operations plastiques du pouce, Acta chir. Scandinav. **93**:231-253, 1946.

615. Martinez Correa, B.: La resección cubital y la recuperación de la prosupinación, Arch. Soc. cirujanos hosp. **15**:798-803 (Dec.) 1945.

of the ulna in 1. Of 3 cases involving older patients, radiocarpal arthritis developed in the first, a comminuted fracture healed with the distal epiphysis of the radius in the wrong position in the second and in the third there was synostosis. Prosupination was lost in all cases. To restore pronation, the inferior extremity of the ulna was resected. In 1 case ulnar resection was not necessary because a pseudarthrosis in the ulna acted in the same way as a resection in favoring rotatory movements of the forearm. There was no pain, and no reduction in power occurred. Any operation to obviate pseudarthrosis is superfluous and dangerous. All patients except 1, who was still under treatment, recovered prosupination in spite of extremely severe bony lesions and also, in some cases, extensive injury to the soft parts. Ulnar resection is a simple operation and can be done under local or plexus anesthesia.

An article by Sutro [616] states that one of the unusual causes of painful snapping or clicking of the wrist is a recurrent subluxation in the intercarpal region. Two cases are presented in which subluxation was produced by a strong active flexion of the fingers or hand.

As a basis of investigation, twelve pairs of normal wrists were observed and roentgenograms taken with the wrists in the neutral attitude, in dorsal flexion and in palmar flexion. Sutro felt that in the 12 cases a minimal anterior subluxation of the distocarpal bones could be produced. In 1 of the 2 cases presented an arthrodesis was performed between the left capitate lunate and navicular bones because of frequent episodes of pain and swelling. A complete disappearance of pain and swelling followed the fusion. It is his opinion that the basis of a recurrent intercarpal subluxation is an overlengthening of the ligaments binding the carpal bone, which imbalances the power between the flexor and the extensor apparatus of the fingers and hand.

A case of backward dislocation of the head of the ulna is presented by Masmonteil and Leuret.[617] A surgical technic described for treatment consists essentially of fixation of the ulnar head in the radius and institution of a pseudarthrosis in the lower third of the ulna by osteotomy and muscle interposition, which permits a rotation of the ulna. This rotation must take place above the inferior margin of the interosseous ligament so that the upper portion of the ulna remains normally fixed to the radius. The results of this method were reported as perfect.

An illustrative case is described in which a girl of 17 years had fractured her wrist. She was able to use her hand on the tenth day,

616. Sutro, C. J.: Bilateral Recurrent Intercarpal Subluxation, Am. J. Surg. **72**:110-113 (July) 1946.

617. Masmonteil, F., and Leuret, J.: Luxation de la tete cubitale en arriere: Traitement par l'operation de Sauve et Kapandji (2e maniere), Mém. Acad. de chir. **72**:353-355 (June 19-26) 1946.

and by the twentieth day function, which had been lost for five years, was restored.

Tranquilli-Leali [618] presents a report in which he states that the curse of dislocation of the wrist is usually that of an extremely long period of recovery, with late cicatrization of the serious periarticular lesions. Retrolunar dislocation of the wrist without fracture can be reduced without operation some hours after injury and causes invalidism for from forty to fifty days. Sixty to seventy days may be required if the dislocation affects the volar or dorsal aspect of the semilunar bone. If the lunar and perilunar dislocations are complicated by fracture of the wrist or radioulnar fracture, the course is doubled because of carpus callus.

Among 77 cases, there were from 100 to 80 per cent good results in 15, from 80 to 60 per cent good results in 30, from 60 to 40 per cent good results in 22 and poor results in 10. In 9 of these 10 cases old dislocations were present. Prognosis is somewhat influenced by the age, the general condition and the site and type of the dislocation. Conservative treatment should be applied at the earliest possible moment. The longer treatment is delayed, the less perfectly will function be restored.

Curr and Coe [619] present 4 cases of dislocation of the inferior radio-ulnar joint, in 1 of which there was dislocation of the proximal and distal joints and in another dislocation of the scaphoid and ulnar joints. Roentgenograms are shown and individual case histories presented. The case of dislocation of the proximal and distal radioulnar joints required open reduction and resulted in almost complete loss of pronation and supination. In the other cases closed reduction was employed, and it produced satisfying results.

An unusual case of dislocation of the scaphoid on the radius is presented. The condition was treated by closed reduction, with a satisfactory realinement of the bone.

A review of portions of the literature and a general discussion followed.

Pygott [620] reported 331 cases of recent injury to bones of the wrist region; 2 of the patients had bilateral injuries. He classified all the injuries and reported the following figures: Fracture of the distal radius occurred in 42 per cent of cases, in 10 per cent of which true Colles'

618. Tranquilli-Leali, E.: Decorso esiti e prognosi delle lussazioni carpiche, Arch. ortop. **57**:163-196 (March) 1942.

619. Curr, J. F., and Coe, W. A.: Dislocation of Inferior Radio-Ulnar Joint, Brit. J. Surg. **34**:74-77 (July) 1946.

620. Pygott, F.: Wrist Injuries in Service Patients, Brit. J. Radiol. **19**:381-382 (Sept.) 1946.

fracture was present, scaphoid fracture in 34 per cent, combined radius and scaphoid fracture in 4 per ceht, carpal dislocation in 3 per cent and Bennett's fracture in 9 per cent. Five patients with Kienböck's disease were seen because of pain, but none had fracture.

Roegholt [621] states that "epicondylalgia" is the correct name for pain and discomfort in the lateral epicondyle and that the condition should not be called "epicondylitis" as no inflammatory process can be demonstrated. Pain in the same region may be caused by such conditions as bursitis and arthritis. Epicondylalgia occurs most frequently in men, especially in laborers who are employed all day in monotonous operations such as hanging clothes, dressing hair, loading trucks or hammering constantly.

In the attempt to determine the cause of this condition, the author made a careful anatomic study of the region in dissected elbows. He draws attention to a tendinofascial bundle inserted at the anterior and inferior margins of the epicondyle. Traction on this structure causes pain. As a curative measure, he suggests transverse incision of this structure 2½ fingerbreadths below the epicondyle. The skin is sutured, and pain is relieved. The patient can resume work after fourteen days.

Stack and Hunt [622] state that so-called tennis elbow is due to various lesions around this joint. Synonymous terms frequently seen in medical writings are epicondylitis, epicondylalgia, radiohumeral bursitis and radiohumeral synovitis. They state that "tennis elbow" covers a multitude of various situations and is not an exact diagnosis.

A sketch which reveals the points of tenderness is shown, and a test for using the hand in pronation and supination in the process of lifting is also discussed. While there is little or no discomfort when lifting with the hand in supination, there is tremendous pain when lifting with the hand in pronation.

If the condition does not respond to the usual conservative treatment such as splinting, diathermy and application of local heat, it is probable that there is radiohumeral synovitis present. The authors recommend open operation, with excision of redundant synovial tissue.

*Pathologic Conditions Involving the Vasomotor Mechanism and Volkmann Contracture.*—A general discussion of Volkmann contracture is given by Clarke.[623] He states that the accepted theory is that venous obstruction causes hemorrhage along the muscle fibers followed by an acute inflammatory reaction and later by diffuse fibrosis. The theory

621. Roegholt, M. N.: Epicondylalgia, Nederl. tijdschr. v. geneesk. **90**:50-51 (Jan. 19-26) 1946.

622. Stack, J. K., and Hunt, W. S.: Radio-Humeral Synovitis, Quart. Bull., Northwestern Univ. M. School **20**:394-397, 1946.

623. Clarke, W. T.: Volkmann's Ischaemic Contracture, Canad. M. A. J. **54**: 339-341 (April) 1946.

of arterial ischemia in which there are massive necrosis and fibrosis of the muscle is also discussed. An investigation of the conflicting views was carried out.

Considerable experimental work was done in which dogs were used and blood pressure cuffs applied to produce stasis. The muscles were also traumatized. Another group of dogs was treated by ligation of the arteries. The author's conclusion was that the condition could easily have either arterial or a venous origin but that it was more probably a result of arterial ischemia. He expressed the belief that ischemia is not due to a tight cast and that the success of early treatment lies in realizing the possibility that arterial obstruction is the cause of contractures.

Ball [624] states that the conception of Volkmann contracture was that it was due to a continuous stoppage of arterial blood. The modern conception is one of venous obstruction and a sequence of tight bandaging and splinting.

A case is reported in which a severe Volkmann contracture occurred as the result of an untreated fracture of the olecranon without displacement. The injury occurred at midnight, and by 11 a. m. the arm was tense, swollen and painful. Complete anesthesia was present from just above the wrist joint to the ends of the fingers. The swelling in the forearm did not involve the hand, but there was complete paralysis of the muscles of the forearm and the hand. Radial and ulnar pulses were palpable and of good volume. Surgical exploration in which the tension of the muscles was freed was carried out. A severe deformity and contracture developed in spite of treatment.

There are 3 other case reports on Volkmann contracture. Marino [625] reports a case of contracture following a supracondylar fracture. He suggests an operative procedure in which a broad incision, with splitting of the aponeurosis, is done and the median and cubital nerves are examined and liberated through their course. Periarterial sympathectomy was performed on the radial and cubital arteries. A Mommsen apparatus was employed to relieve the contractures.

In de Leo's case [626] the condition was secondary to a wound on the forearm. He also performed periarterial sympathectomy of the humeral artery and freed the muscles. Elastic traction was used to relieve the contracture. He states that functional results after seven months were not encouraging.

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624. Ball, L.: Volkmann's Ischaemic Contracture of Forearm, M. J. Australia **1**:224-225 (Feb. 16) 1946.

625. Marino, H.: Retraccion isquemica de Volkmann; incision exploradora, operacion descomprensiva, Prensa méd. argent. **32**:2413-2415 (Dec. 7) 1945.

626. de Leo, F.: Contributo alla patogenesi della malattia di Volkmann, Chir. d. org. di movimento **30**:90-105 (Jan.-March) 1946.

The danger of hemostatic bandages (Esmarch bandages) is stressed by Mester.[627] He feels that the so-called tourniquet may, under war conditions, lead to fatal shock and severe anaerobic infections and that the use of such bandages should be avoided whenever possible. It is impossible to check and control the tourniquet adequately, and an Esmarch bandage which has been on more than two hours should be removed in stages so that the patient is given a better chance to neutralize liberated toxins. Local pressure dressings are considered to be far superior.

*Dupuytren's Contracture.*—Desplas and Tostivint[628] reported on a series of 107 patients; 150 hands and 120 operations were involved. After a general discussion of the etiologic and pathologic factors in Dupuytren's disease, the authors recommend the performance of a partial aponeurectomy when possible. They consider total intervention unjustifiable in the treatment of contractures of limited extent. They do stipulate, however, that all pathologic tissue must be removed. Frequently it is the cutaneous infiltration rather than the too conservative operation which leads to failure. Cutaneous defects can be filled in by various methods of grafting. The technic is planned to fit four types of defects: (1) localized palmar nodule or unidigital or paucidigital cord under a relatively normal skin—a partial aponeurectomy is indicated; (2) localized type, with considerable cutaneous infiltration—a partial aponeurectomy is indicated, with excision of the diseased skin followed by a dermal-epidermal graft; (3) extensive involvement under normal skin—since the radial portion of the aponeurosis is usually intact, wide but not total aponeurectomy is indicated, with conservative treatment of the skin (bridge flap), and (4) extensive involvement, with pronounced infiltration of the skin—wide aponeurectomy is indicated, with excision of the diseased skin followed by grafts.

Results were mediocre in 26 cases and poor in 6. Partial or full recurrence may be expected in a certain proportion of cases. General anesthesia is preferable. Extremely sharp, small instruments should be used to avoid laceration. Details of technic are described. After operation there should be no hyperextension; rather the fingers should be in a flexed position.

A series of 111 patients with Dupuytren's contracture, including 101 men and 10 women, is presented by Einarsson.[629] The average

627. Mester, Z.: Ueber die Gefahren der blutstillenden Gliederabschnurung, Schweiz. med. Wchnschr. **75**:1033-1035 (Nov. 24) 1945.

628. Desplas, B., and Tostivint, R.: A propos de 150 cas de maladie de Dupuytren, Mém. Acad. de chir. **71**:373-379 (Oct. 17-31) 1945.

629. Einarsson, F.: On Treatment of Dupuytren's Contracture, Acta chir. Scandinav. **93**:1-22, 1946.

age was 51 years. In all, 164 hands were affected, and 84 hands were treated surgically. Excision of the palmar aponeurosis was carried out on 68 hands. The results were excellent in 43 cases (69 per cent), fair in 7 cases (11 per cent) and poor in 12 cases (20 per cent).

Whenever practicable, excision of the palmar aponeurosis is indicated. In cases of mild contracture in young persons excision of the palmar aponeurosis should be done as a prophylactic measure. In cases of mild contracture in patients over 50 years of age expectant treatment is justifiable because of the slow progress of the contracture. In cases of severe contracture in adults operation to relieve the deformity is advised.

When the general condition is good and prospects of healing are favorable, excision of the palmar aponeurosis is recommended, but in cases of severe articular contracture digital amputation may be required, the soft parts from the amputated finger being used to cover the defect in the palm left by excision of the aponeurosis. The incision should be made along the natural creases of the palm. Incision in the finger should be anterolateral.

Ayre [630] reports on a series of 486 veterans of the guard who were examined for Dupuytren's contracture. Of these, 34 had early contracture, 25 moderately advanced contracture and 2 complete contracture. The thumb was involved in 1 case. In another there was fibrous induration of the penis. The author presents a brief review of the history, etiology, pathology and clinical features of this condition. In the present group no definite etiologic factor could be demonstrated. There was no evidence to support previous theories of causation with the exception of the theory of traumatic origin.

In civil life this condition occurs chiefly in manual workers, and it would seem that similar influences might be at work in the army after four years of daily guard duty involving the handling of a rifle for the greater part of the day.

*Appraisal of Disability.*—Slocum and Pratt [631] feel that the fundamental appraisal of the disability of the hand should be concerned with function. The article presented deals with the evaluation of disability of the hand and does not include the arm.

The purpose of the presentation is to introduce a simplified method of disability evaluation which incorporates the time-tested values set

630. Ayre, W. B.: Dupuytren's Contracture: Report of Sixty-Four Cases Among Veterans Guard of Canada, J. Canad. M. Serv. **3**:57-61 (Nov.) 1945; Canad. M. A. J. **54**:158-160 (Feb.) 1946.

631. Slocum, D. B., and Pratt, D. R.: Disability Evaluation for Hand, J. Bone & Joint Surg. **28**:491-495 (July) 1946.

forth in the past. Disability evaluation has a dual purpose: first, its traditional use in the appraisal of the end result of trauma as disease for an insurance company or an industrial accident commission; second, (and herein lies the most important purpose from a medical viewpoint) the determination of disability as a basis for planning treatment. It enables the surgeon to judge how worth while his procedure is.

The authors divide the functions of the hand into three—those of grasp, pinch and hook. The percentage values for function are 50 per cent for grasp, 30 per cent for pinch and 20 per cent for hook. The entire value of the thumb is rated as 40 per cent, because it makes up 25 per cent of grasp and 15 per cent of pinch.

A varying percentage is determined for the loss of such a portion of a metacarpal and a phalanx. There is also evaluation as to loss of sensation. It is valued at 50 per cent of the value of the hand.

*Tumors.*—Zuckerman and Proctor [632] state that a report of injuries to blood vessels in World War I reveals that aneurysms occur in 1 per cent of wounds of the extremities. A general classification of aneurysms is presented.

The traumatic arterial type of aneurysm may be subdivided into two categories, both of which are characterized by damage to the vessel wall resulting from some form of trauma. The true form is distinguished by a weakened wall which is pushed ahead and dilated, thus forming a sac.

In the false variety, or pulsating hematoma, there is a tear in the vessel wall, with ensuing hemorrhage. Varying amounts of blood take part in the formation of the hematoma, which may or may not be well demarcated from the surrounding tissue and which may burrow into the soft structures or tissue along the fascial plains. The differentiation between the true and the false aneurysm can be made from the presence or absence of muscle elements in the wall of the aneurysmal sac.

A survey of the literature reveals that Middleton reported 70 cases in 1933; in 44 the false form was present and in 16 the true form. There were 14 cases of traumatic aneurysm, but in these the condition was not a result of an open wound. The findings in cases of aneurysm are an expansive pulsating tumor, a scar from preceding injury (in the false type of aneurysm), a variable amount of pain, depending on the structures compressed by the tumor, a weak pulse distal to the aneurysm and a possible bruit over the mass.

A case of true traumatic aneurysm is presented in which treatment was surgical excision of the tumor.

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632. Zuckerman, I. C., and Proctor, S. E.: Traumatic Palmar Aneurysm, Am. J. Surg. **72**:52-56 (July) 1946.

Wildervanck [633] reported on a case in which a man 30 years of age had "knuckle pads." The "pads" were at the joints of the first and second phalanges of the fingers of the right hand. They had been present for a few months. No occupational factor could be demonstrated. Some weeks before, the patient had noticed a pain in these joints on grasping an object firmly. The "pads" were apparently attached to the upper skin. Clinically, they appeared to be of a connective tissue structure and not hyperkeratotic. They were movable over the underlying tissues. Excision of a fragment confirmed the diagnosis. Histologically, there was only a thick horny layer.

In 1940 Carol described 2 cases of acanthosis and hyperkeratosis. There is no agreement as to the cause. Some writers believe that chronic trauma is a factor. Hadorn in 1944 presented a detailed account of the condition, with a bibliography. A distinction must be made between "pseudo-knuckle pads" and the extremely rare genuine type. Occasionally the pads disappear spontaneously. "Pseudo-knuckle pads" are associated with acanthosis and hyperkeratosis. In the present case no exogenous contributing factor could be demonstrated.

## XIII. AMPUTATIONS, APPARATUS AND TECHNIC

**Prepared by**

**J. WARREN WHITE, M.D., GREENVILLE, S. C.**

ALTHOUGH hostilities had ceased the year before they were written, the majority of the one hundred and eighty articles on this subject could be considered as written from military experience. Over fifty foreign articles cited in the *Quarterly Cumulative Index Medicus* were unobtainable, and there was little new in the others except what will be listed in the following paragraphs.

*Amputations.*—Most of the articles on amputations reported series of cases interesting from one angle or another, and only three had to do with refrigeration anesthesia. Nothing particularly new has been advocated, but the use of ice rather than refrigeration machines seems to be in order, and there is emphasis on the simplicity of the ice equipment.[634]

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633. Wildervanck, L. S.: Case of "Knuckle Pads," Nederl. tijdschr. v. geneesk. **90**:179-181 (March 2-9) 1946.

634. Miller, H. I., and Miller, P. R.: Refrigeration in Surgery, Am. J. Surg. **72**:694-699 (Nov.) 1946. Massie, F. M.: Refrigeration Anaesthesia for Amputation, Tr. South. S. A. **57**:472-482, 1945. Allen, F. M.: Amputation: Uses of Cold in Surgery, Clinics **4**:1642-1674 (April) 1946.

A paper has been published by Tobias [635] discounting severely the value of refrigeration anesthesia and citing the higher mortality accompanying this type as compared with spinal anesthesia produced by cyclopropane. This is a well documented article and deserves serious consideration. He states that the advantage of the diminution of toxic agents and the reduction of the local metabolism were completely discounted by the anoxic stumps, which made an ideal field for the development of anaerobic organisms and caused a delay in wound healing. The title is misleading, however, and it is mentioned here because of the derogatory observations on refrigeration anesthesia.

Meyer [636] has written a paper describing in detail the formation of skin flaps to avoid a secondary amputation in guillotine procedures. The article is a good one worth reading, but it is feared that the technic could not be applied in the usual case in which the guillotine amputation is indicated and that the existence of the flaps would too frequently defeat the purpose for which the amputation was originally intended.

Once more American authors (Alldredge and Thompson [637]) have written to extol the Syme amputation in an article of a military nature. There is nothing new in it, however, and it is mentioned here as an excellent defense of a procedure still generally and unjustifiably in ill repute in America.

The treatment of painful stumps and phantom limbs has been discussed in seven articles. Horrax [638] discusses the value of cortical excisions when other methods have failed, while Pisetsky [639] describes the use of electric shock treatment in such instances. The two papers present new methods worth considering in the extreme cases in which both surgeon and patient are at the end of their rope.

Guillaume, Bertrand, and Mazars [640] again advocate the employment of myelotomy and discuss rather in detail the physiopathologic causes of painful stump.

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635. Tobias, M. J.: Supracondylar Amputations (Including Evaluation of Refrigeration Anesthesia), Ann. Surg. **123**:473-480 (March) 1946.

636. Meyer, N. C.: Guillotine Amputation Modified to Preserve Skin Flaps, U. S. Nav. M. Bull. **46**:1844-1847 (Dec.) 1946.

637. Alldredge, R. H., and Thompson, T. C.: Syme Amputation, J. Bone & Joint Surg. **28**:415-426 (July) 1946. Alldredge, R. H.: Indication for Syme Amputations, S. Clin. North America **26**:422-431 (April) 1946.

638. Horrax, G.: Amputations: Experiences with Cortical Excisions for Relief of Intractable Pain in Extremities, Surgery **20**:593-602 (Nov.) 1946.

639. Pisetsky, J. E.: Disappearance of Painful Phantom Limbs After Electric Shock Treatment, Am. J. Psychiat. **102**:599-601 (March) 1946.

640. Guillaume, J.; Bertrand, I., and Mazars, G.: Case of Painful Stump Treated by Myelotomy, Rev. neurol. **77**:145 (May-June) 1945.

Rarely in these days is ligation of nerves recommended, but Cieslak and Stout [641] recommend it in addition to cutting high. They do not make injections into the nerve, however; this is another procedure which has been long discarded.

White [642] discusses in detail the mechanism of pain in neuromas and advises against the patient's waiting too long for relief because of the possibility of the developmeont of drug addiction with its distressing sequelae. Repeated resectioning of neuromas should not be done; neurectomies performed higher up as well as reamputation are useless. Except for radical leucotomy, central neurosurgical measures should be employed as a last resort only.

The early encouragement of atrophy of muscle in below-the-knee stumps by neurectomy was first advocated by Adams.[643] This procedure may be necessary in the treatment of extremely muscular persons.

One article was written on hindquarter amputation and three on forequarter amputation. All the amputations were done for malignant tumors. Berman [644] cites 2 cases in which this mutilating operation was done on the upper extremity, with only an eighteen month follow-up of the oldest patient!

The article on hindquarter amputation was written by Pack and Ehrlich,[645] and it gives an excellent description of the technic employed, describing 3 new cases in which operation was performed successfully by the authors. Disarticulation of the hip joint for malignant growths was also discussed in a preceding article in this series. They state that the original 50 per cent mortality accompanying hemipelvectomy has been reduced to less than 15 per cent.

Blair and Morris [646] discuss the improvement of the function of short stumps by tendon section, particularly just distal to the elbow and in below-the-knee stumps. The sectioning of the biceps brachialis adds 2 inches (5.08 cm.), while a like amount is added to the below-the-knee stump when all the hamstrings are severed. This is a well written and well illustrated article.

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641. Cieslak, K., and Stout, A. P.: Traumatic and Amputation Neuromas, Arch. Surg. **53**:646-651 (Dec.) 1946.

642. White, J. C.: Painful Injuries of Nerves and Their Surgical Treatment, Am. J. Surg. **72**:468-488 (Sept.) 1946.

643. Adams, A. O.: Tibial Neurectomy to Produce Atrophy of Amputation Stumps, J. Bone & Joint Surg. **28**:716-720 (Oct.) 1946.

644. Berman, J. K.: Interscapulothoracic Disarticulation of Arm, Surgery **18**:256-266 (Aug.) 1945.

645. Pack, G. T., and Ehrlich, H. E.: Exarticulation of Lower Extremities for Malignant Tumors, Ann. Surg. **123**:965 (June) 1946.

646. Blair, H. C., and Morris, H. D.: Conservation of Short Amputation Stumps by Tendon Section, J. Bone & Joint Surg. **28**:427-433 (July) 1946.

Jones and Ryan[647] have reviewed 549 amputation cases in the navy; 88 of the patients required reamputation, while 197 required revisions. They stated that 95 per cent of patients on whom guillotine amputations were done required reamputation (revision?), while only 21 per cent of those who had undergone some type of flap operation required further surgical treatment while in the authors' hands. Postoperative complications were more rare after the flap operations. Revisions and reamputations were done only when the stump was completely healed.

Jones and White[648] make a valuable analysis of 829 cases; the patients were treated in naval hospitals largely under the supervision of one man. This is an excellent article which, however, has little new in it.

McKeever,[649] discussing controversial points in relation to amputations, includes ten points in his summary that deserve special mention and make this article the best one of the year on amputations in general. His article deals with amputations in relation to military life, as do most other articles citing long series of cases in which amputation was performed. The various points McKeever makes are as follows:

1. The guillotine amputations are safest in the presence of sepsis.
2. Fascia and skin or skin alone should be the only covering of an amputation stump. Complete hemostasis is necessary.
3. Phantom limbs are the rule and need no treatment. Painful phantom limbs, fortunately rare, are not relieved by operation and are usually associated with drugs, alcohol or psychic factors.
4. Pedicle grafts are not satisfactory for weight-bearing stumps. Skin grafting is not necessary if traction and proper after-care are carried out.
5. End-bearing stumps are desirable in young persons. The Syme amputation gives the best possible stump.
6. Even a 1 inch stump in below-the-knee amputations is worth while.
7. Partial amputation of the foot should be done only if the anterior group of muscles can be saved.
8. A humeral stump above the insertion of the pectoralis major has no functional value. Elbows should always be saved if possible.

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647. Jones, D. T., and Ryan, T. C.: Amputee Rehabilitation: Problems of Revision and Reamputation, U. S. Nav. M. Bull., March 1946, supp., pp. 37-64.

648. Jones, D. T., and White, W. L.: Rehabilitation—Statistical Analysis of 829 Amputation in 769 Patients, U. S. Nav. M. Bull., March 1946, supp., pp. 12-19.

649. McKeever, F. M.: Discussion of Controversial Points in Amputation Surgery, Surg., Gynec. & Obst. **82**:495-511 (May) 1946.

Long stumps with the carpal bones in are worth while, but disarticulation through the wrist is not satisfactory.

9. Cineplasty should rarely be done, if ever.

10. Physical therapy is in order for habilitation of patients with stumps. Massage per se is of little value.

In regard to articles on amputation in general, nothing really new has been proposed. There has been some discussion in various articles on improving prostheses, but aside from small mechanical details such as slight changes in the design of the knee joint and a further discussion of the merits of an inner socket, nothing original has appeared. The results of research work on this important subject being carried on are yet to be made public.

*Apparatus.*—There has appeared this year fewer publications to be placed under this general division.

Bunnell [650] has written an article on the use of spring or elastic splints "to coax joints from the position of nonfunction into that of function and to maintain them so." To make this possible and physiologically correct, according to his teaching, Bunnell explained in detail the specifications for splints that make the surgical restoration of a hand more possible. The author claims that rigid splinting causes rigid hands and should be studiously avoided in surgical treatment of tendons and joints directed toward physiologic motion of parts rather than simple correction of deformities such as that effected by osteotomies or bone grafts. It is an article which should be kept handy for reference by surgeons employing Bunnell's methods and as a supplement to his classic book on the subject.

Along the same line, Pruce [651] has devised a splint to be used to prevent the development of claw hand resulting from injury. The author emphasized the fact that the splint maintains rather than corrects existing deformities. It apparently is particularly valuable as a prophylactic measure in treatment of injuries of the ulnar nerve.

Bond [652] has described another similar splint for finger traction possibly of a more active nature than that recommended in the previous two articles. He advocates the use of a trochar pointed piano wire for skeletal finger traction.

The present day dissatisfaction with conventional treatment of fractured forearms and the tendency toward mechanization are shown in

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650. Bunnel, S.: Active Splinting of Hand, J. Bone & Joint Surg. **28**:732-736 (Oct.) 1946.

651. Pruce, A. M.: Sprint to Correct Deformity (Clawhand) Resulting from Injury, J. Bone & Joint Surg. **28**:397 (April) 1946.

652. Bond, B. J.: Small Type Skeletal Traction Apparatus, U. S. Nav. M. Bull. **46**:124-126 (Jan.) 1946.

the publication of several articles on the reduction of fractures in this area. The tendency has been encouraged by the scarcity of assistants and orderlies, which too frequently requires the surgeon to work almost by himself. Rose [653] has described a device for the reduction of fractures of the forearm employing traction and countertraction; the countertraction is exerted against the flexed upper part of the arm. For most of these splints the old Chinese finger trap grip, so valuable when great force is needed for a short while, is employed.

Gunther and Holzer [654] have reported another traction-countertraction apparatus similar in many ways to the one devised years ago by Souter except possibly that it has a somewhat more universal application. The article is well illustrated and calls attention to a principle that has not been sufficiently employed by the younger surgeons.

A metacarpal splint which works on the direct pressure principle rather than on the traction principle has been designed by Goldberg.[655] In his hands it apparently works well, and those wishing to try something different from the somewhat cumbersome conventional apparatus are advised to read the article.

A fourth splint has been described by Batemen,[656] but it is feared that its efficiency in a few instances has been sacrificed for universality. After reading the article, one is impressed and believes the principles to be sound although the splint must be cumbersome. The reviewer would be a little hesitant about using it.

Donehue [657] has improvised a modification of the Stokes navy stretcher for the handling of a patient with a difficult pelvic fracture when suspension is desirable. The apparatus would rarely be needed in civilian practice, but the article calls attention to another stretcher which the reviewer does not think is employed enough during these days of frequent roadside injuries and plane crashes when patients have to be carried long distances over rough terrain.

Goeringer [658] describes a "lawn chair" frame for transporting patients in plaster hip spicas. The need for rapid transportation of patients in

653. Rose, R. M.: Simple Traction Device for Reduction of Fractures of Forearm, J. Bone & Joint Surg. **28**:176-177 (Jan.) 1946.

654. Gunther, W. A., and Holzer, N. T.: Forearm: Apparatus for Reduction, U. S. Nav. M. Bull. **46**:1760-1763 (Nov.) 1946.

655. Goldberg, D.: Metacarpal Fractures: A New Instrument for Maintenancy of Position After Reduction, Am. J. Surg. **72**:758-766 (Nov.) 1946.

656. Bateman, J. E.: Universal Splint for Deformities, J. Bone & Joint Surg. **28**:169-173 (Jan.) 1946.

657. Donehue, F. M.: Wounds and Injuries: Combined Stretcher and Treatment Bed for Transportation, U. S. Nav. M. Bull. **46**:444-446 (March) 1946.

658. Goeringer, C. F.: Aid to Handling of Patients in Hip Spica Casts, Mil. Surgeon **99**:130-132 (Aug.) 1946.

the army created a demand which is not encountered in civilian practice. This is a good companion article to Donehue's.

For the surgeon who has been dissatisfied with the way he has been able to apply figure-of-8 plasters in cases of injury of the clavicle, Lewin [659] has reported a simple method of holding the shoulders back and yet not interfering with the application of the plaster. While the arms were held akimbo a broomstick was passed in front of the elbows and behind the back, which separated most efficiently the two ends of the clavicle while the padded plaster was being applied.

Deaver and Brown [660] have written a rather complicated but detailed article on "Prescribing Crutch Gaits for Orthopedic Disabilities." These authors have made many valuable contributions to orthopedic literature, and this article is no exception. One must have read several of their previous articles to be able to follow the course of reasoning easily. An interesting point mentioned is the undesirability of using one crutch. They claim that it encourages the uneven use of the whole body. In previous articles on the use of crutches they warn continually against the use of padding on the top axillary bar of the crutch and stress the importance of having the grips properly placed for weight bearing.

After his rich experience in the European Theater during the War, Diveley [661] calls attention once more to the value of using the convalescent period for a reconditioning process and maintains that, after all, rehabilitation is a part of the treatment. He recommends convalescent care in civilian hospitals even in a separate wing. The responsibility of the physician in regard to the rehabilitation of the injured person is emphasized. During these days of high hospital costs and because of the scarcity of hospital beds, most of this must be done as outpatient service. It is a matter, he rightfully claims, which should be brought up continually before hospital staffs.

A simple and yet efficient foot exerciser for bed use has been reported by Schroeder [662] after several years of successful use. It is simply designed and yet provides easily regulatable resistance in the horizontal position. It is automatically pushed into the upright position and prevents foot drop and is a useful piece of apparatus to have available for patients who must spend a time in bed.

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659. Lewin, P.: Simple Method by Means of Which Patient Holds His Own Shoulders Backward and Upward, Am. J. Surg. **71**:368-369 (March) 1946.

660. Deaver, G. G., and Brown, M. E.: Prescribing Crutch Gaits for Orthopedic Disabilities, Arch. Phys. Med. **26**:747-758 (Dec.) 1945.

661. Diveley, R. L.: Rehabilitation of Sick and Injured, Occup. Med. **2**:201-206 (Sept.) 1946.

662. Schroeder, C. F.: Therapeutic Foot Exerciser, J. Bone & Joint Surg. **28**: 648-649 (July) 1946.

Many articles on reconditioning have appeared in the medical publications of the army and the navy in addition to Deaver and Brown's, but since little new has been recommended they will not be mentioned.

An excellent historical article on "Thomas and His Splint" was written abroad by McMurray [663] which calls attention to the value of the splint of that name and which for all time will establish the need for this simple apparatus so universally used in fractures of the femur.

The description of another hyperextension back brace has been published by Bradford and Graham.[664] Those who are able to use either the Baker or the Chambers brace would not be particularly interested in it as it differs little in construction and not at all in function from those already adequately described in the past.

*Technic.*—Under this title will be discussed new surgical instruments and devices for use during surgical procedures.

Verbrugge,[665] of Belgium, has published a description of a bone-holding forcep which he had with him on his visit to America. A great many who saw it were favorably impressed, and it is hoped that a domestic instrument house will manufacture it. It is an improvement on the Lambotte bone holder as the handle is offset so as to be out of the way for bone plating, grafting or drilling. The article is accompanied with a plate embodying to some extent the McBride screw-staggering idea that has definite merit.

The value of Bunnell's "pull-out" wire suture for implantation and fixation of tendons was discussed favorably by Key [666] in two publications. He approved of the method and considered it to be a valuable addition to surgical technic. It might be added here that it is well to adhere strictly to Bunnell's technic as the reviewer knows of several instances in which the anchorage of tendons has not held after the Bunnell technic was employed.

Current interest in spinal exploratory operations is shown by the description by Riekert and Luomanen [667] of a new hemilaminectomy

663. McMurray, T. P.: Thomas and His Splint, Brit. M. J. **1**:872-875 (June 8) 1946.

664. Bradford, C. H., and Graham, W. C.: Hyperextension Back Brace, Mil. Surgeon **98**:40-42 (Jan.) 1946.

665. Verbrugge, J.: Improved Bone Clamp and Plate for Internal Fixation of Fractures, J. Bone & Joint Surg. **28**:174-175 (Jan.) 1946.

666. Key, J. A.: Fixation of Tendons, Ligaments and Bone by Bunnell's Pull-Out Wire Suture, Tr. South. S. A. (1945)**57**:187-194, 1946; Fixation by Bunnell's Pull-Out Wire Suture, Ann. Surg. **123**:656-663 (April) 1946.

667. Riekert, H. J., and Luomanen, R. K. J.: Self-Retaining Hemilaminectomy Retractor, Am. J. Surg. **71**:436-437 (March) 1946.

retractor of the self-retaining variety. The particular innovation is the use of one blade designed especially for exerting countertraction against the spinous processes. The arm of the blade is angulated at its base so as to be well out of the operative field. The reviewer has never seen this instrument but was impressed by the description and the apparent applicability.

Taylor [668] has devised another spinal retractor which, it is claimed, assists the retractor holder during spinal operations. Its efficiency depends on the small projection at the deep end which is slipped under the lateral edge of the articular facet employed as a fulcrum. The reviewer has used this retractor with satisfaction and feels that no damage has been done by the rather deep penetration of the projecting end.

Another guide for nailing fractures of the femoral neck, which consists of a fork, has been described by Gaston [669]; when used according to the directions, one prong lies anterior to the neck and the other posterior. After roentgenologic study, the nail is driven between the prongs. This was simply a preliminary report without clinical background.

The careless manufacturing of stainless steels of various alloy content to be used in one surgical procedure has been emphasized by Key [670] with justifiable indignation. The American College of Surgeons, which has in the past attempted to standardize plates and screws, should take this important problem on its program and prevent an endless amount of grief in the future. Key states with scientific accuracy: "In the light of what is known about the deleterious effect on bone of electrolysis caused by the use of metals of different composition for internal fixation, it is just as important that the metals used for internal fixation of bone be standardized as it is that drugs be of uniform purity and potency."

Eggers [671] reports the successful use of tantalum foil as an interposing layer in arthroplastic procedures on the jaw. No sutures are employed in this rather deep location, and it is claimed that the foil is molded by the opposing bone surfaces in use. Further reports on the use of this material in a group of cases will be looked forward to.

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668. Taylor, G. M.: Simple Retractor, J. Bone & Joint Surg. **28**:183-184 (Jan.) 1946.

669. Gaston, F. H.: Femur-Guide for Nailing Fractures of Neck, South. M. J. **39**:690-692 (Sept.) 1946.

670. Key, J. A.: Electrolytic Absorption of Bone Due to Use of Stainless Steels of Different Composition for Internal Fixation, Surg., Gynec. & Obst. **82**:319-322 (March) 1946.

671. Eggers, G. W. N.: Arthroplasty of Temporomandibular Joint in Chicken with Interposition of Tantalum Foil: Preliminary Report, J. Bone & Joint Surg. **28**:603-606 (July) 1946.

Eggers[672] has described a bone plate slotted to allow continuous bone contact as absorption of fracture ends occurs. This follows up the idea of Gilfilin in possibly a more efficient way.

Lambert and Horwitz[673] have described three instruments which they claim facilitate the performance of the Bankhart operation for recurrent dislocation of the shoulder. One is a forked "pusher" to get the humeral head out of the way and permit the visualization of the lesion on the anterior glenoid lip, another is a right angle drill for properly placing the sutures in the damaged capsule and the third is a specially devised right angle suture carrier. They state that they have been considerably aided in the performance of their last eight Bankhart operations for recurrent dislocation of the shoulder.

Immediate surgical treatment of vessels is discussed by Mustard,[674] who has employed glass tubes of proper caliber at the preliminary operation, to be replaced within six days by venous grafting. He states that one of the main difficulties is the heparinization of the patient through proper laboratory cooperation. He is not too optimistic about the results from this heroic type of surgical intervention but feels that it is a beginning in a new field.

Mayer,[675] of New York, has published reports on operations on vertebral bodies—another heroic procedure. He discusses 6 cases, in 2 of which the lumbar bodies were approached between the erector spinae group and the quadratus lumborum. Drainage for pyogenic infection was performed successfully in 2 cases. Fatal termination occurred in 2 cases after exploration of neoplastic (malignant) processes, and in another there was recovery from an aneurysmal bone cyst of the seventh dorsal body.

The ability of tissue to tolerate nylon both for buried and cutaneous sutures, is reported on favorably by Rowe,[676] particularly when bone is involved and when other forms of suture are contraindicated. Its use in repair of acromioclavicular separations, metarsus primus varus and fractured patellae is reported. One difficulty which the reviewer has had with nylon sutures is his inability to tie a knot which continues tight.

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672. Eggers, G. W. N.: Contact Splint, Texas Rep. Biol. & Med. **4**:42-45, 1946.

673. Lambert, R. G., and Horwitz, T.: Three Instruments Designed to Facilitate Bankhart Operation for Recurrent Dislocation, J. Bone & Joint Surg. **28**: 641-643 (July) 1946.

674. Mustard, W. T.: Arterial Wounds: Technic of Immediate Restoration of Vascular Continuity; Indications and Results, Ann. Surg. **124**:46-59 (July) 1946.

675. Mayer, L.: Operations on Bodies of Vertebrae, J. Internat. Coll. Surgeons **9**:104-111 (Jan.-Feb.) 1946.

676. Rowe, M. J.: Nylon Suture, Surgery **18**:764-768 (Dec.) 1945.

To assist in early closure of extensively débrided wounds, Gay [677] has advocated the extensive use of split skin grafts between the fifth and tenth day after injury. He is of the opinion that the thinner the graft is the more it is liable to survive. This is another article written from experiences in military service.

Eggers and Rowland [678] have called attention to the ease with which the proximal one third of the humerus is exposed through a posterolateral curved incision from the tip of the shoulder to the deltoid tuberosity. It occurs to the reviewer also that this may be desirable for cosmetic reasons.

Lattes and Frantz [679] noted that the presence of oxidized cellular sponges seemed to interfere considerably with the repair of bone. No clinical experience otherwise was cited, but its use as an interposing membrane in such procedures seems appropriate. The idea may be a good one, but one is a little afraid that tissue might be intolerant to the amount which would be effective.

A subject which deserves further elaboration has been discussed by Klinefelter,[680] i. e., the malinterpretation of roentgenograms. Unnecessary operations might be performed or necessary operations might not be performed if roentgenograms are misinterpreted, and the author justifiably calls attention to the necessity of knowing just how each exposure is made. This brief article opens up a field for discussion of great practical value. It is hoped that the subject will be gone into more extensively by those who are capable of correctly interpreting roentgenograms and have a practical clinical insight.

Several authors have discussed the use of ice as a therapeutic or postoperative aid other than an anesthetic for amputations. Schaubel [681] emphasizes its use as a postoperative aid in containers about casts, stating that the need for splitting casts was reduced from 42 to 5 per cent by the generous use of ice bags.

Massie [682] once more advocates the use of ice in keeping an extremity anesthetized and properly preserved pending the conditioning of

677. Gay, E. C.: Skin Dressings (Splint Grafts) in Treatment of Debrided Wounds, Am. J. Surg. **72**:212-218 (Aug.) 1946.

678. Eggers, G. W. N., and Rowland, R. H., Jr.: Incision for Exposure of Proximal One Third of the Humerus, M. Rec. & Ann. **40**:1551-1558 (Sept.) 1946.

679. Lattes, R., and Frantz, V. K.: Absorbable Gauze in Bone Surgery, Ann. Surg. **124**:28-39 (July) 1946.

680. Klinefelter, E. W.: Influence of Position on Measurement of Projected Bone Angle, Am. J. Roentgenol. **55**:722-725 (June) 1946.

681. Schaubel, H. J.: Local Use of Ice After Orthopedic Procedures, Am. J. Surg. **72**:711-714 (Nov.) 1946.

682. Massie, F. M.: Refrigeration Anaesthesia, Ann. Surg. **123**:937-947 (May) 1946.

a patient for necessary surgical treatment, particularly, of course, after severe trauma. There is nothing new in this article, but it is hoped that throughout the country emergency rooms in large hospitals will become more familiar with this valuable lifesaving procedure in treatment of severely injured patients.

Increased interest in anesthesia produced by cold is shown by two articles that appeared in journals devoted to anesthesiology.[683] It is the reviewer's opinion that anesthesiologists were unjustifiably discounting the value of this method of reducing pain and producing surgical anesthesia.

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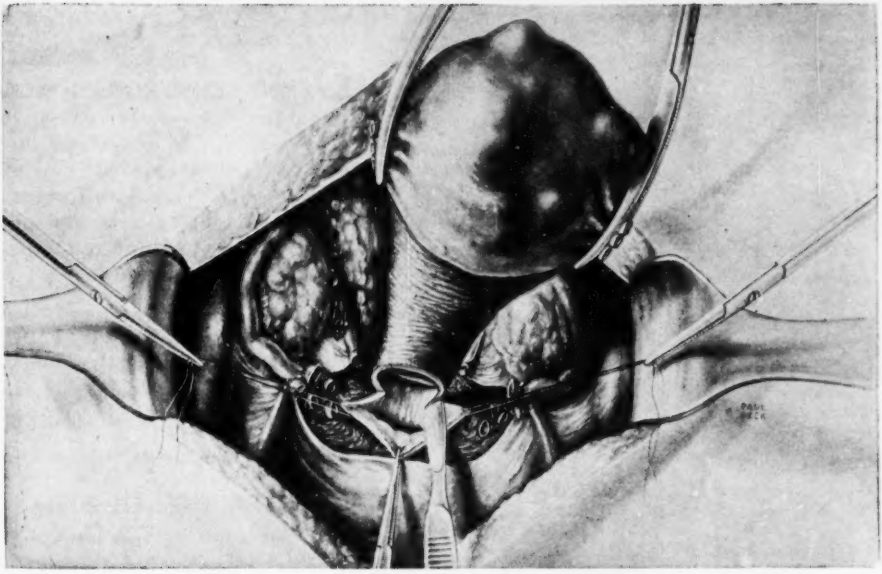
683. Kanaar, A. G.: Refrigeration in Treatment of Trauma, with Review of Crymotherapy, Anesth. & Analg. **25**:177 (Sept.-Oct.); 228 (Nov.-Dec.) 1946. Lobachev, S. V.: Refrigeration Anaesthesia in Surgery of Extremities, ibid. **25**: 22-30 (Jan.-Feb.) 1946.



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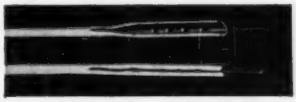

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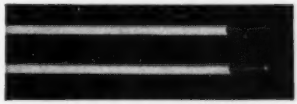

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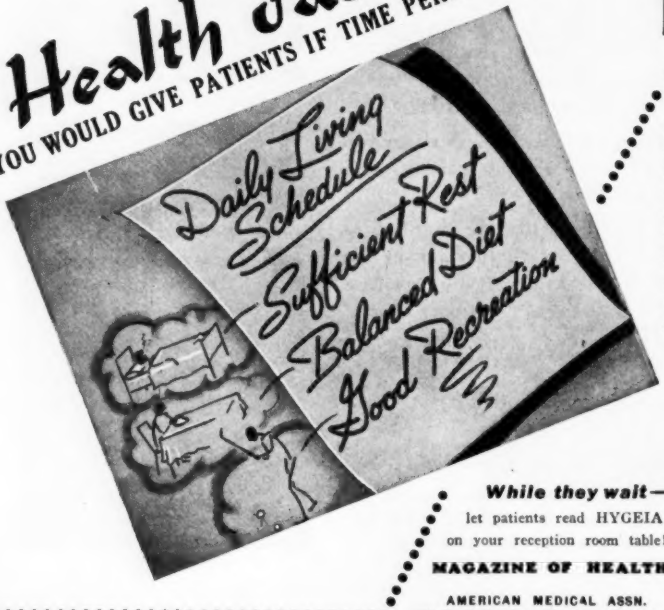


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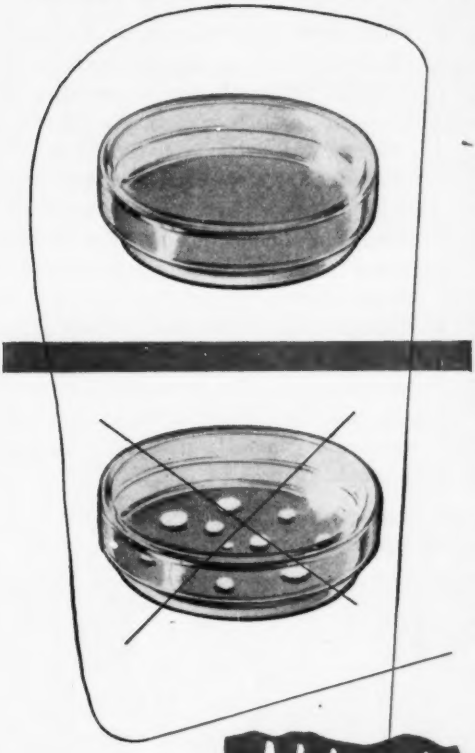

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